Aquatic Enhancement
& Survey, Inc.

Aquatic Plant Management Plan 2007-2011
Hamilton Lake
Steuben County, Indiana

Prepared for the Hamilton Lake Association

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Executive Summary

Hamilton Lake is an 802 acre Kettle Lake in Steuben County Indiana. It has a maximum depth of 70 feet and an average depth of 21 feet. The public can gain access to Hamilton Lake through an Indiana Department of Natural Resources (hereinafter referred to as IDNR) access ramp at Circle Park on the west shore of the lakes southeast basin. A private access is located at a Marina near the northeast corner of the lake. Residents and users who access Hamilton Lake enjoy fishing, swimming, boating, skiing, and tubing in the waters of the Lake. Hamilton Lake is a popular location for bass fishermen and hosts several tournaments and bass club outings each season. Hamilton Lake contains a diverse aquatic flora, but has been extensively colonized by the non-native plants Curlyleaf pondweed *Potamogeton crispus* and Eurasian watermilfoil *Myriophyllum spicatum*. For several years these plants have impaired the aesthetic quality of the lake and provided a significant hindrance to the recreational activities of the lake's users. A program of aquatic pesticide applications has been ongoing for several years to clear enough vegetation to allow for reasonable public use and keep the lakes populated shorelines aesthetically pleasing for residents. Beginning in the 2005 season the Hamilton Lake Association sought cost-share assistance from the Indiana Department of Natural Resources for the management of exotic plants. This plan supplants the original Indiana Department of Natural Resources Lake and River Enhancement Program (L.A.R.E.) cost-share funded *Hamilton Lake Integrated Aquatic Plant Management Plant Management Plan 2005-2009* (Weed Patrol Inc. 2005) and associated updates. The purpose of this plan is to help the Hamilton Lake Association and IDNR direct management efforts toward the following set of goals for Hamilton Lake:

1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

Hamilton Lake underwent a "whole lake" treatment with the herbicide Sonar in 2006 for control of Eurasian watermilfoil. Whereas Sonar treatments are capable of providing multi-seasonal control of target plants problems with Eurasian watermilfoil in the 2007 season have been minimal. Aquatic plant surveys conducted according to IDNR protocol in July and August (Tier II aquatic plant sampling) showed Hamilton to have a moderately diverse plant community, however the growth of the invasive exotic plant Curlyleaf pondweed expanded in 2007 and it was necessary to treat over 100 acres for the plant. Eurasian watermilfoil, the main problem plant on Hamilton Lake in the past, generally was not a problem during 2007. Eurasian milfoil growth however was found in Crystal Bay and Crystal Cove, two newly constructed channel system subdivisions connected to Hamilton Lake. This area contains about 41 surface acres of water and was not included in the 2006 season whole lake treatment. Small colonies of milfoil were also found growing in the main lake. All areas of milfoil growth were treated as they were located to help delay recolonization of the lake by this invasive plant.

To continue with successful management of aquatic plants the Hamilton Lake Association is advised to treat all areas of significant Curlyleaf pondweed growth in 2008 with an early season treatment (preferably in April or when water temps. are approx. 55 deg F) using Aquathol K herbicide. The early treatment may be able to successfully prevent reproduction of the Curlyleaf plants by dropping them before they can form fertile turions (seed structures) thus diminishing their numbers in later seasons. The Hamilton Lake Association is also advised to continue with the chemical treatment of Eurasian watermilfoil with 2, 4-D granular aquatic herbicide as it continues to re-colonize the main lake. At Crystal Bay and Crystal Cove a treatment of the entire subdivision with fluridone is advised as the most efficacious way to stop milfoil growth in this area and prevent the formation of dense colonies that will seed vegetative spread into other parts of the lake. Continued efforts at educating lake users about the spread and management of invasive aquatic plants are also recommended. Because taking care of the Hamilton Lake watershed will ultimately help to minimize aquatic plant problems on the lake the Hamilton Lake Association is advised to continue with current efforts to address erosion along tributary streams and throughout the watershed. Based on the exotic plant growth area in 2007 a cost estimate of $51,000.00 is provided for early-season treatment of Hamilton Lake's Curlyleaf pondweed in 2008 (170 acres). An estimated 50 acres of returning Eurasian watermilfoil will need to be treated in 2008 at a cost of $20,000.00. The estimated cost of a fluridone treatment to kill Eurasian watermilfoil growing in Crystal Bay and Crystal Cove is $9800.00. The total estimated cost for the recommended exotic aquatic plant control program in 2008 including consultant costs is $86,450.00. The table below contains all estimated costs for plant management under this plan 2008-2011. Actual treatment areas should be adjusted during the 2008 season through on-site surveys of emerging growth. The Hamilton Lake Association and IDNR should maintain the flexibility to adjust the management program on-the-fly in response to actual growth areas as Hamilton Lake's plant growth can vary considerably from season to season. The Hamilton Lake residents may wish to continue some treatment of native plants or filamentous algae as allowed by District Fisheries personnel.

●**Success Benchmarks:** 5% or less occurrence of Curlyleaf and Eurasian milfoil in July Tier II Survey	**2008**	**2009**	**2010**	**2011**
Month/Activity				
April, Map Curlyleaf pondweed And Eurasian watermilfoil growth	1300.00	1300.00	1300.00	1300.00
April/May (soon after emergence) Treat Curlyleaf pondweed as needed (.5-1ppm Aquathol K)	51,000.00	51,000.00	51,000.00	51,000.00
May, Begin Eurasian treatments on main lake as needed	20,000.00	40,000.00	91,600.00	8000.00
May, 6 ppb fluridone application for Eurasian m. (Crystal Bay and Cove) Initial dose, bumps, and assays	9800.00			
June, Algae/native plant treatment as needed/permitted	(HLA costs)	(HLA costs)	(HLA costs)	(HLA costs)
July, Tier II Survey	1800.00	1800.00	1800.00	1800.00
As arranged, Public Meeting	350.00	350.00	350.00	350.00
October/November, Permit Meeting	300.00	300.00	300.00	300.00
December, Plan Update Document Due	1900.00	1900.00	1900.00	1900.00
Total Cost, Pesticide Applications	**$80,800.00***	**$91,000.00***	**$142,600.00***	**$59,000.00***
Total Cost, Consultant	**$5650.00**	**$5650.00**	**$5650.00**	**$5650.00**
Total Exotic Costs	**$86450.00***	**$96650.00***	**$148,250.00***	**$64,650.00***
HLA algae treatment	**$1200.00**	**$1200.00**	**$1200.00**	**$1200.00**
Total	**$87,650.00**	**$97,850.00**	**$149,450.00**	**$65,850.00**

Figure 1 Hamilton Lake General Location

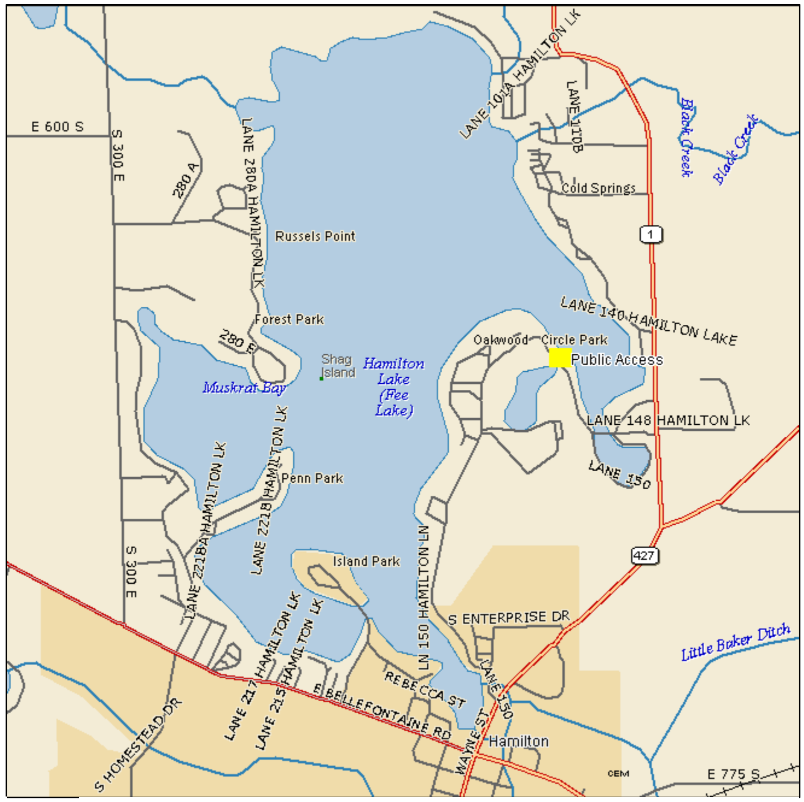


Figure 2 Hamilton Lake and Surrounding Area

1.0 Introduction

The invasive exotic aquatic plant Eurasian watermilfoil has been well established in Hamilton Lake for many years. Hamilton has undergone several years of herbicidal plant control to maintain useable recreational waters in the face of colonization by non-native plant species. Eurasian watermilfoil has extensively colonized the lake, achieving a peak dense growth area of approximately 264 acres of the lake. For several years the Hamilton Lake Association and residents have hired licensed aquatic pesticide applicators to treat up to 100 acres of the lake per year to provide relief from the excessive growth in key areas. In 2003 a whole lake treatment with granular fluridone (Sonar) herbicide provided good control of the Eurasian watermilfoil problem, but by 2005 it was necessary to treat 45 acres of returning milfoil. The Hamilton Lake Association achieved funding through the IDNR Lake and River Enhancement Program (LARE) to develop a plant management plan in 2005. For the original draft plant management plan for Hamilton Lake see *Hamilton Lake Integrated Aquatic Plant Management Plant Management Plan 2005-2009* (Weed Patrol Inc. 2005). After the original plan was drafted the Hamilton Lake Association received partial cost-share assistance for exotic plant control in the 2006 season. The whole lake granular fluridone treatment was repeated in 2006 and achieved control of Eurasian watermilfoil on a lakewide basis by fall. That winter the Hamilton Lake Association applied to the IDNR Lake and River Enhancement Program (LARE) for assistance in developing this new management plan document and treating exotic plants in 2007. A small amount of returning milfoil was noted and treated during the 2007 season. Absent the competitive influence of dense milfoil growth in 2007 Curlyleaf pondweed, another exotic invasive plant grew excessively on over 100 acres of Hamilton Lake. The Curlyleaf was treated with a combination of LARE funds and Lake Association funds. The intent of this plan is to act as guiding document for management activities for Hamilton Lake for 2008-2011.

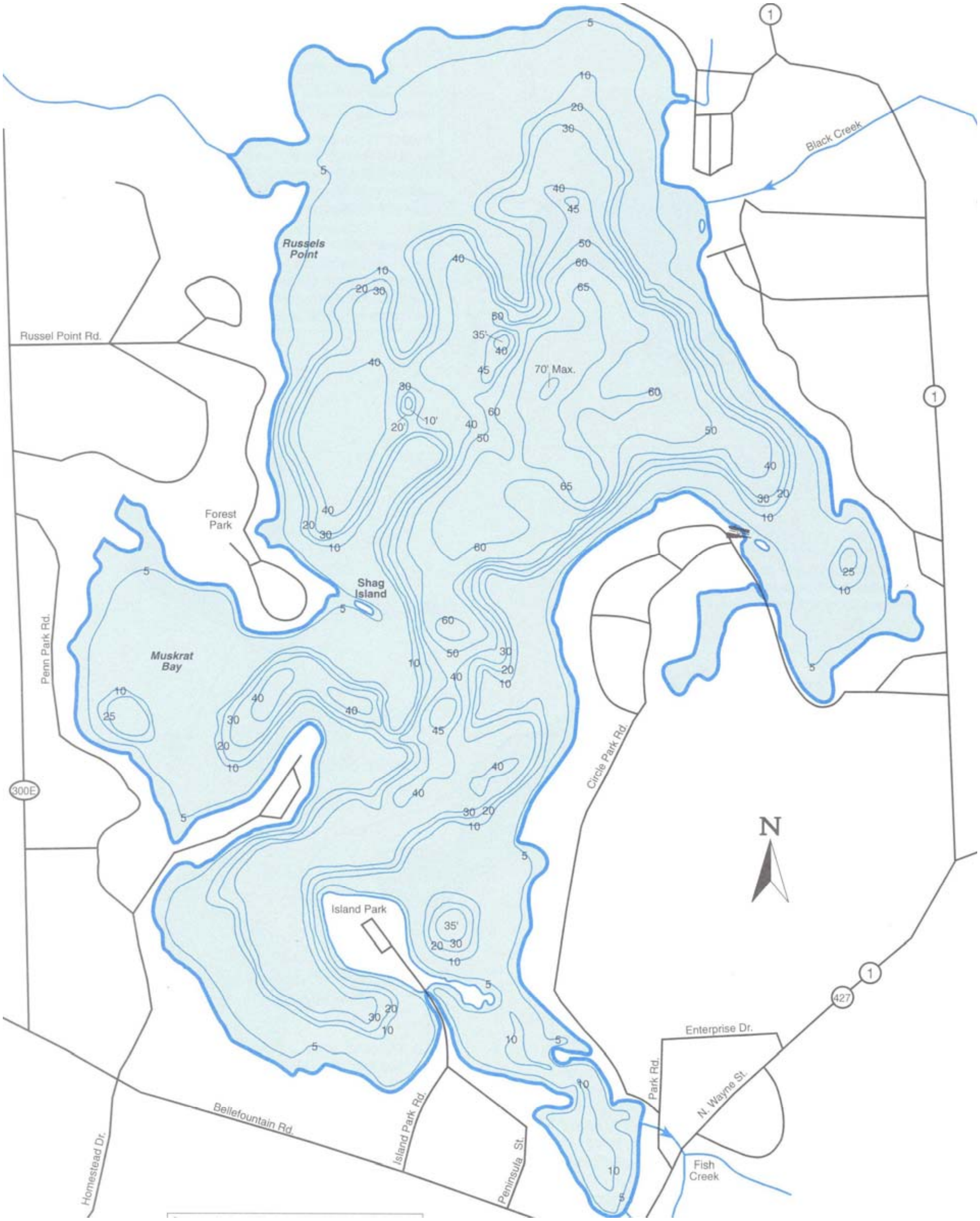


Figure 1 Hamilton Lake Contour Map, Source, Sportsman's Connection, IDNR Depth Data

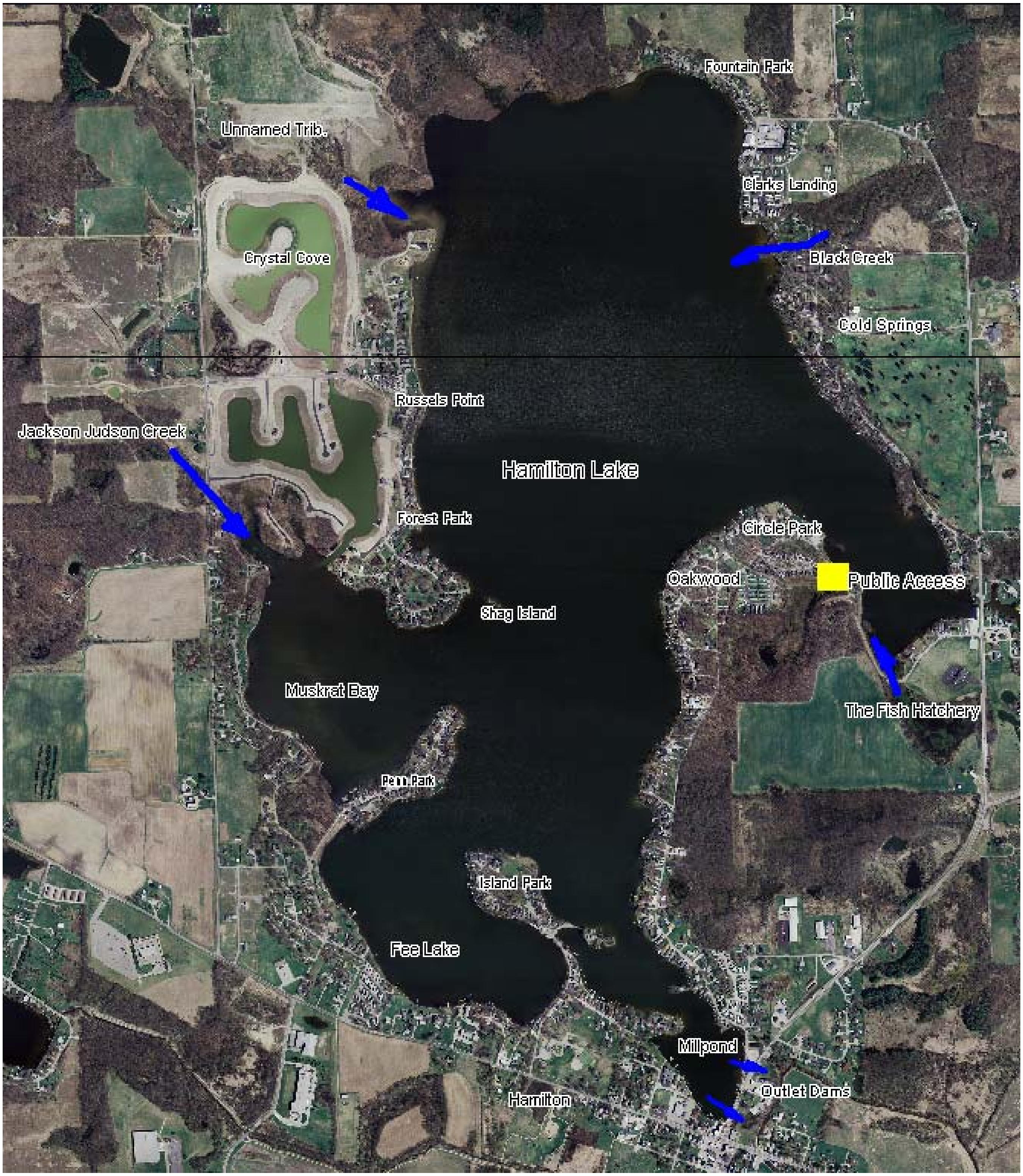
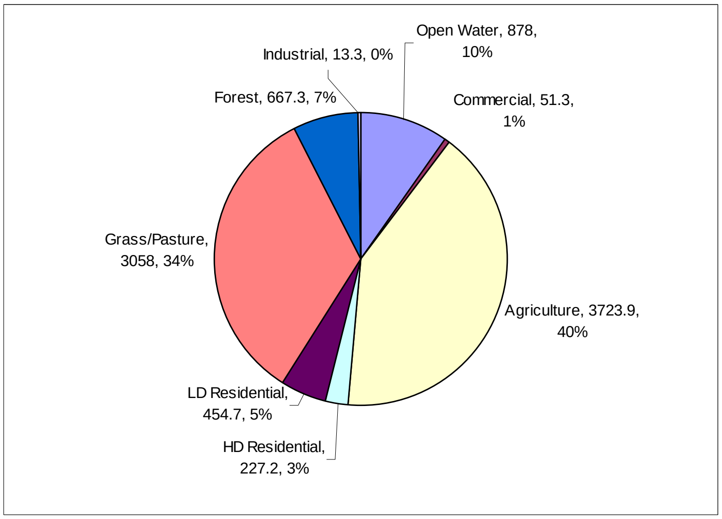


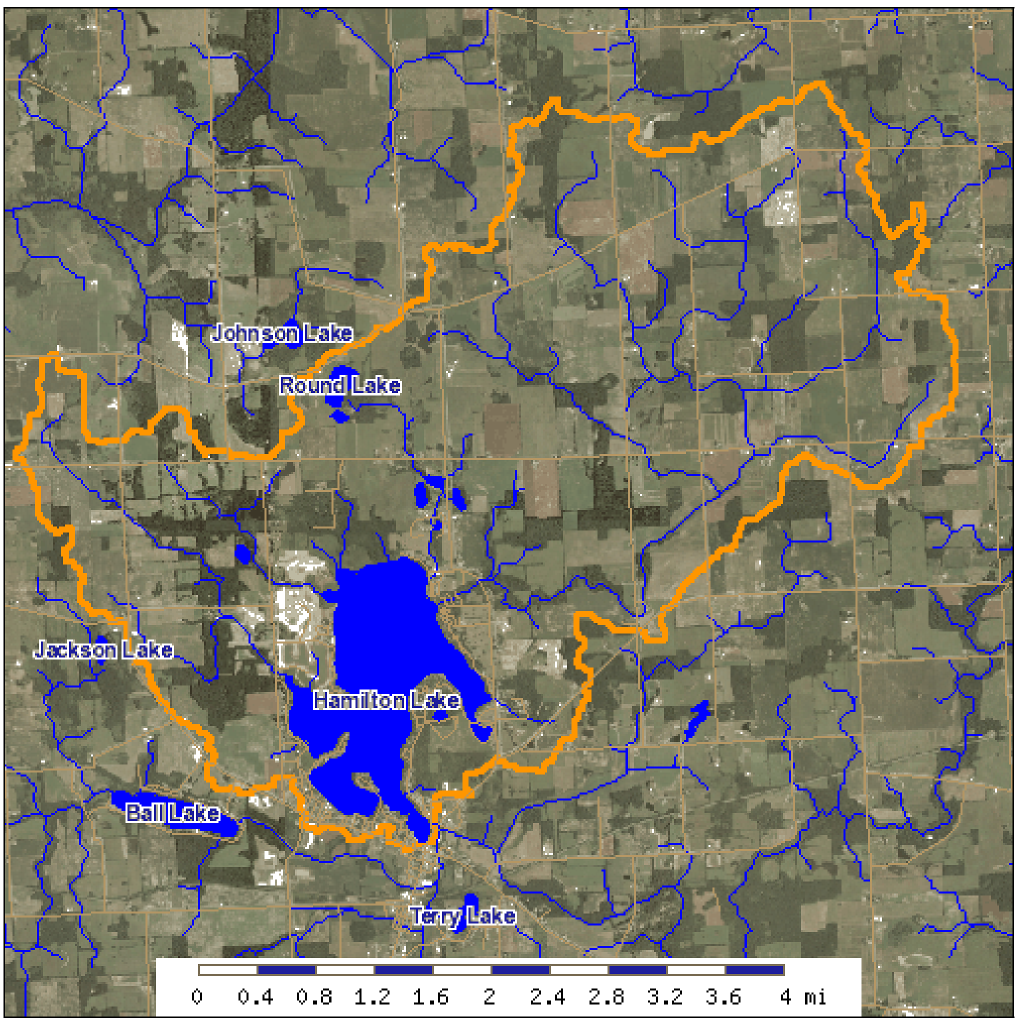
Figure 2 Air Photo of Hamilton Lake and Surrounding Area

2.0 Watershed and Lake Characteristics

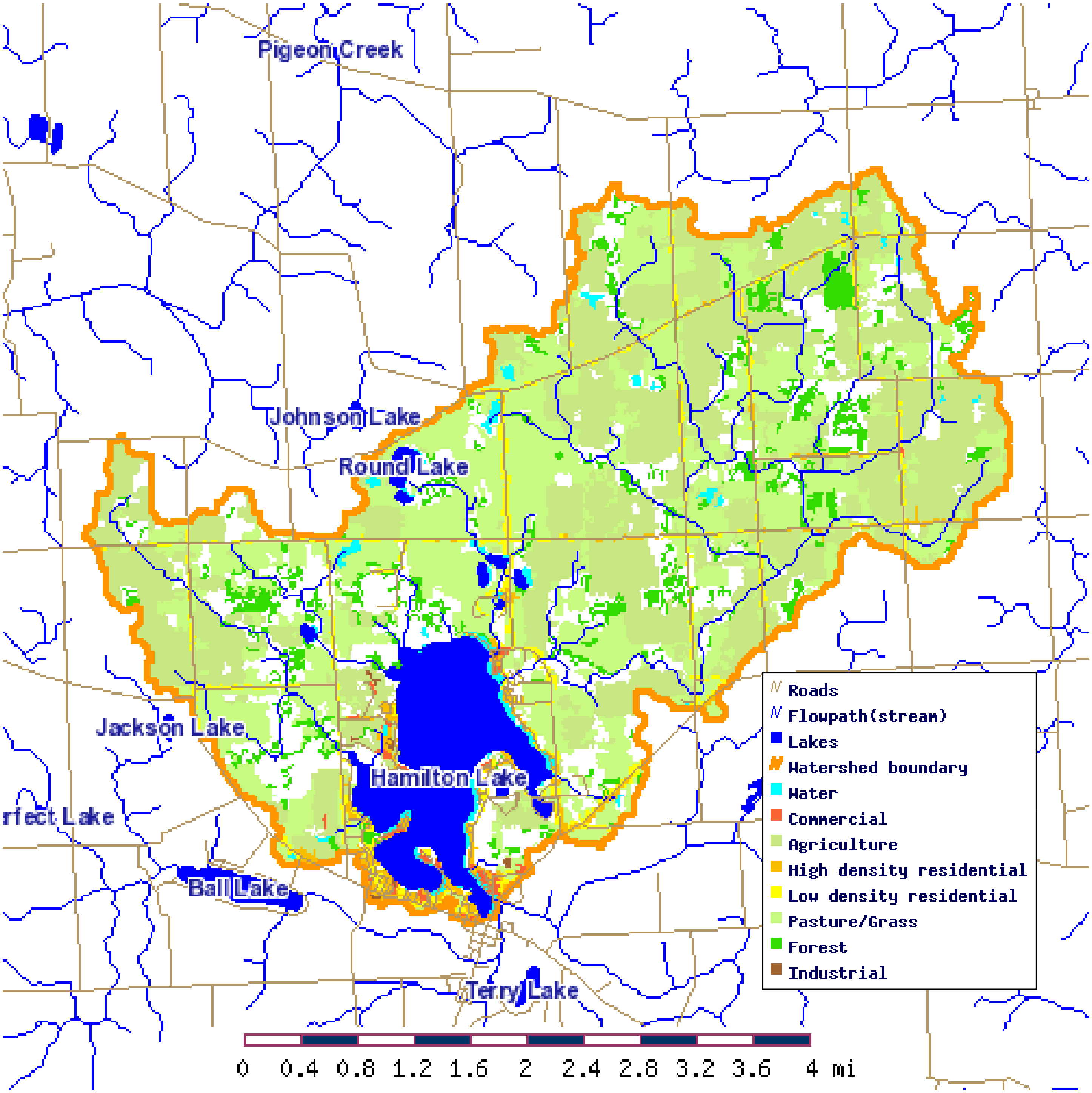
The shoreline of Hamilton Lake is approximately 80 percent developed with single family homes, cottages, and businesses (INDR 2004). The most significant tributaries to Hamilton Lake include Black Creek along the northeast shoreline of the lake, Jackson Judson Creek entering Muskrat Bay on the Lake's west side, and another unnamed intermittent tributary entering a small bay in the northeast corner of the lake (figure 2 above). A marshy pond known as "The Fish Hatchery" drains into the southwest corner of the easternmost bay of the lake. Three small intermittent drainages also enter at the north end of the lake as does one through an excavated channel at the southeast corner of the lake's southeast bay. Hamilton Lake owes its nutrient-rich "eutrophic" state to its sizeable watershed of approximately 10873 acres (maps 1 and 2 below). The watershed is mostly agricultural (40 percent), but also contains significant pasture (34 percent), and woodlands (7 percent). About 22 percent of the watershed is developed. Lakeside homes on Hamilton Lake are on a centralized wastewater collection system operated by Hamilton's conservancy district. The water level in Hamilton Lake is maintained by concrete dams near the lake's southernmost point. Hamilton Lake has a complex shoreline with the southern half of the lake divided into several distinct basins. The lake's southernmost basin known as "The Millpond" is within the city of Hamilton. The bathymetry of Hamilton Lake generally allows for abundant plant growth on littoral shelves along the shoreline of several parts of the lake (figure 3). Shallow flat areas with plant growth include the Millpond, Muskrat Bay, and a wide littoral shelf at the lake's north end. Hamilton Lake has been generally nutrient rich (eutrophic) for many years and has low to moderate warm season water clarity compared to most other northeast Indiana lakes. A Secchi depth of six feet was recorded in June of 2007, while a Secchi depth of four feet was recorded in August, 2007. In the past five years Hamilton's surface area has been expanded by approximately 41 acres with the addition of a recently excavated channel system off of the lakes west side (see figure 4 above). The Hamilton Lake association has taken many steps toward improving water quality in the lake beginning with an IDNR sponsored T-by- 2000 feasibility study in 1990 (Harza 1990). The feasibility study noted a large amount of sediments entering the lake from Black Creek and Jackson Judson Creek (photo 1 below) and noted that row-crop production on highly erodible lands was a dominant land-use in the watershed. It was recommended that Hamilton Lake apply to the T-by 2000 program to design and construct a series of wetlands in the watershed to trap lake-bound sediments. The Harza study also recommended a switch from herbicide applications to harvesting to control aquatic plants. A phosphorus inactivation project was recommended after the implementation of the first two recommendations. This was followed up in 1991 by an environmental review of six possible wetland project sites (Harza Review 1991) and a subsurface exploration (Harza Exploration 1991) which displayed preliminary designs and developed site-specific data on soils and necessary easements. By 1999 the six possible wetland sites had been narrowed down to a single feasible project site with respect to permitting and land ownership. This site on Haughey ditch, in the Black Creek watershed was further examined and designs were developed by Harza with funding assistance from the Indiana Department of Natural Resources and the USDA Natural Resources Conservation Service (Harza 1999), but the project was never carried out. A search of the National Heritage Database indicated that Richardson's pondweed *Potamogeton richardsonii* a state "rare" species was documented as growing in Hamilton Lake in 1935. This species was also noted growing in 2007 at Crystal Bay and Crystal Cove. Additionally the state species of special concern amphibian Common mudpuppy *Necturus maculosus,* was documented in Hamilton Lake. No date was available.



Graph 1 Land Use in the 10873 acre Hamilton Lake Watershed



Map 1 Air Photo of the Hamilton Lake Watershed



Map 2 The Hamilton Lake Watershed. Data and graphic from Agricultural and Biological Engineering, Purdue University Website

Photo 1 Hamilton Lake After a Rainstorm in 1989 Showing Sediment Input from Black (Creek Entering Upper Right) and Jackson Judson Creek (Entering Bay on Left) (Photo Harza 1990)

3.0 Lake Uses

With regard to swimming, fishing, and navigation nearly the entire developed shoreline of Hamilton Lake can be considered “high use” (figure 3 below). Nearly all residents have watercraft and must navigate in and out of docking areas. Additionally the southeast bays of Hamilton Lake are home to restaurants and other businesses where patrons can moor watercraft temporarily and enjoy a view of the Hamilton Lake waters. A popular run for water skiers exists across the large littoral flat at the lake’s north end. Crystal Bay the south tier of the newly constructed channel system off of the lake’s east shore contains several new homes where watercraft are moored and new lots are sold and built upon each season. Boat traffic is often present moving too and from the main lake in this area. Main Lake residents often tour and cruise the new subdivision. Crystal Cove, the north Tier of this development does not yet contain houses and docks. As development progresses Crystal Cove will also become a high traffic area. Noting the high use areas of Hamilton Lake will be important both in preventing vegetative spread of fragmenting exotic plants and prioritizing areas for plant control.

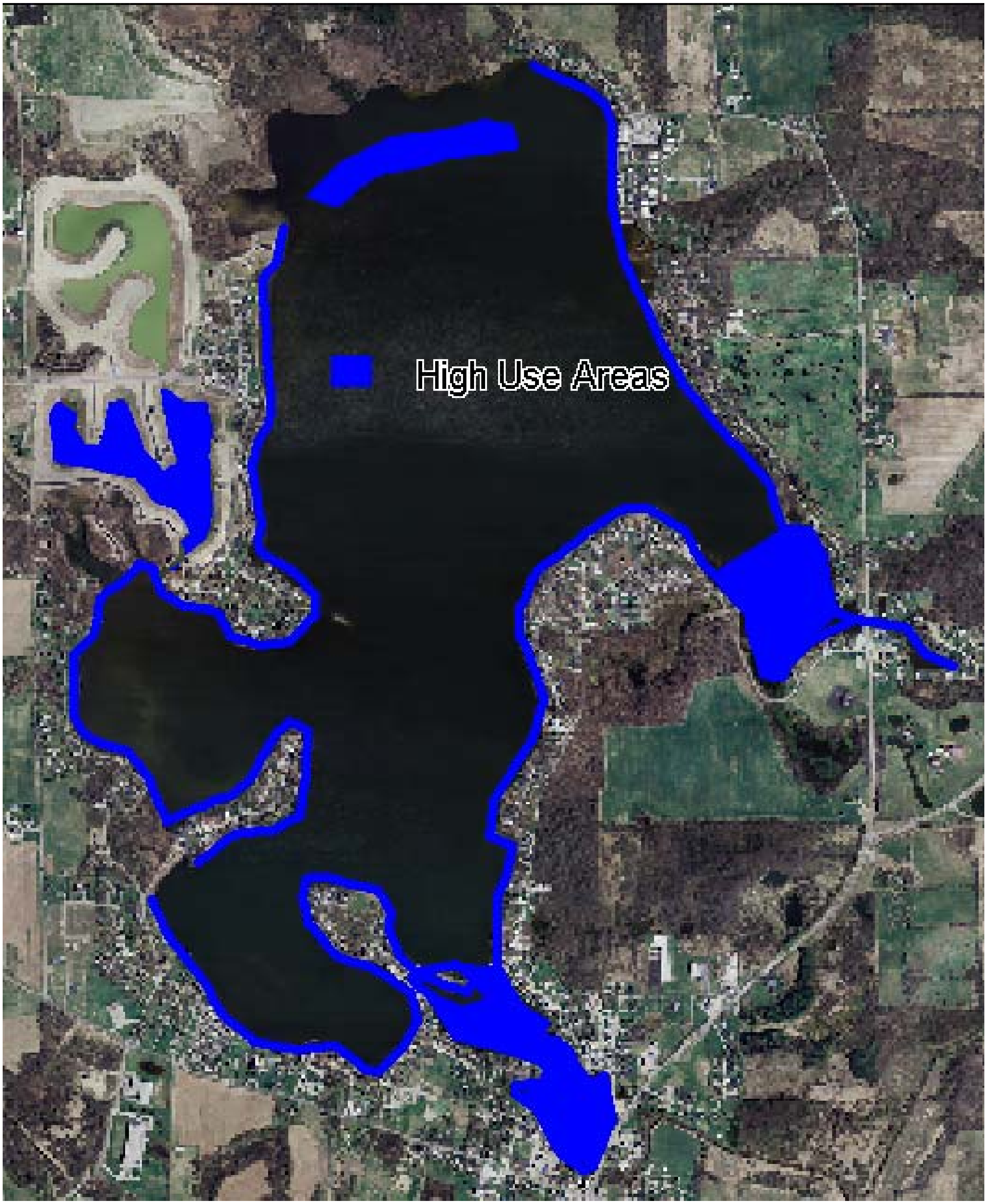


Figure 3 High Use Areas of Hamilton Lake

SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER AND WEIGHT					
*COMMON NAME OF FISH	NUMBER	PERCENT	LENGTH RANGE (inches)	WEIGHT (pounds)	PERCENT
Bluegill	1,755	56.6	1.7 - 7.3	119.42	15.2
Redear	415	13.4	3.4 - 7.0	31.48	4.0
Black crappie	319	10.3	4.4 - 12.0	39.84	5.1
Yellow perch	164	5.3	4.5 - 8.7	13.53	1.7
Pumpkinseed	94	3.0	3.1 - 7.3	8.62	1.1
Gizzard Shad	91	2.9	5.4 - 14.3	40.49	5.1
Northern pike	67	2.2	21.6 - 39.0	354.67	45.1
Brown bullhead	65	2.1	5.7 - 13.1	32.21	4.1
Largemouth bass	57	1.8	3.6 - 20.4	55.45	7.0
Warmouth	31	1.0	2.8 - 7.3	3.06	0.4
White crappie	10	0.3	6.6 - 11.0	2.11	0.3
Yellow bullhead	7	0.2	7.2 - 11.8	2.97	0.4
Bowfin	6	0.2	19.6 - 28.8	26.86	3.4
White sucker	6	0.2	7.1 - 14.5	6.57	0.8
Common carp	4	0.1	25.6 - 28.8	33.98	4.3
Longnose gar	4	0.1	18.5 - 44.0	15.26	1.9
Golden shiner	2	0.1	3.6 - 6.6	0.11	**
Lake chubsucker	1	0.0	7.6	0.21	**
Madtom	1	0.0	2.8	0.02	**
Brook silversides	Abundant				
Total (20 Species)	3,099			786.86	

*Common names of fishes recognized by the American Fisheries Society.

**Less than 0.1 percent

Figure 4 Species and Relative Abundance of Fishes Collected from Hamilton Lake in the 6/14-17/04 IDNR Survey

4.0 Fisheries

Hamilton Lake is well known as an area fishery. With a thriving gizzard shad population Hamilton Lake has produced a well-known Largemouth bass and Northern Pike fishery. Several large bass tournaments and bass club outings are held there each year. The lake is also known as an excellent Black crappie fishery; however IDNR fisheries biologist noted a lack of large Bluegill in Hamilton Lake with the longest specimen collected in the most recent fish survey being only seven inches in length. It was noted that the bluegill and other panfish species probably have a poor size structure because of competition with the lake's large Gizzard shad population. The last IDNR fisheries survey for Hamilton Lake was conducted in June of 2004. A total of 3,099 fish representing 20 species were collected with a combination of gill-netting, trap netting, and nighttime D.C. electrofishing. The species and relative abundance list for the 2004 survey is in Figure four above. A creel survey was also performed by IDNR at Hamilton Lake in April through October of 2004. Hamilton anglers fished a total of 18,577 hours during the creel survey. Hamilton Lake drew fisherman from 19 Indiana County's other than Steuben County, as well as anglers from Michigan and Ohio. Most who visited the lake were fishing for bass. Lake residents accounted for 19.7 percent of all anglers. Because Hamilton Lake is Eutrophic, aquatic plant management there will be a balancing act which seeks to reduce exotic invasive growth enough to allow recreational activities, while maintaining enough native plant biomass to provide adequate cover and habitat. Elimination of too much native vegetation could potentially boost nutrient levels in the lake, further degrade water clarity, and cause harmful algae blooms or even fish kills. Areas of Hamilton Lake not considered "high use" should remain refuges to support a luxuriant growth of native aquatic vegetation. Developed shoreline areas where resident's use of the lake is not severely restricted can also be areas where native plant growth is preserved as well. Carefully regulating dose rates of whole lake treatments, timing widespread contact herbicide treatments properly, controlling and preventing the spread and introduction of existing and newly introduced exotic plants are all steps that can assist in maintaining balance in the Hamilton Lake fishery. Working in the watershed and lake to prevent nutrient and sediment sources can improve water clarity over time and also encourage the growth of native vegetation.

5.0 Problem Statement

Exotic plants provide impairment to Hamilton Lake directly and indirectly by out-competing more beneficial native species for resources, contributing to a loss of diversity, impairing recreational use, and providing a complex habitat that can alter fish community functioning. Additionally the Eutrophic conditions of Hamilton Lake can potentially be exacerbated if dense invasive vegetation is managed by allowing the lake to be colonized extensively and abruptly providing control during the growing season. This can produce a nutrient rich situation where the plant community biomass is dominated by blue-green or filamentous algae.

6.0 Vegetation Management Goals and Objectives

The IDNR Division of Fish and Wildlife and LARE program staff have formulated three aquatic vegetation management goals that apply to Hamilton Lake and other Indiana Lakes. The goals are as follows:

1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

Recommended management activities at Hamilton Lake will be geared toward attainment of these goals with the following objectives maintained as measurable benchmarks for success:

1. Maintain the occurrence of dense Curlyleaf pondweed and Eurasian watermilfoil growth at or below 10% of the total Hamilton lake littoral area. (post-treatment)

2. Maintain the occurrence of Curlyleaf pondweed and Eurasian watermilfoil in the late season Tier II survey at or below five percent.

7.0 Plant Management History

Treatments for Eurasian watermilfoil and other plants have been ongoing at Hamilton Lake for many years. Exotic plant management activities for the past six years are summarized in the table below. Hamilton Lake tends to gravitate toward colonization of approximately 264 acres by Eurasian watermilfoil if left unmanaged. Prior to 2003 the Hamilton Lake Association would raise enough funds to treat approximately 100 acres of milfoil targeting key "high use" areas of shoreline. Milfoil outside these areas was allowed to grow and reproduce. Since 2003 whole lake treatments have been initiated, followed up in the subsequent 2 seasons by a "seek and destroy" herbicidal management policy on all known milfoil plants to delay the return of the plants as a problem. Granular fluridone herbicide has been used in 2003 and 2006 (6ppb rate) to gain complete control over Eurasian watermilfoil. Granular product was chosen to help prevent a rapid loss of fluridone concentration if rainy conditions cause a rapid flushing of the lake. Curlyleaf pondweed growth at Hamilton Lake has been highly variable and difficult to predict. During some seasons treatment has been unnecessary. In 1996 and 1999, 40 acres were treated for Curlyleaf. In 2000 the treated area increased to 60 acres and treatment was again needed in 2004 on 65 acres. The growth soared to 170 acres in 2007 with 144.5 acres prioritized and treated (figure 5 below). In 2007 approximately nine acres were treated for Eurasian watermilfoil with 2,4-D granular herbicide. Since the whole lake fluridone treatment in 2006 Eurasian watermilfoil is slowly recolonizing the lake and the 2007 treatments were performed to kill all returning milfoil growth as it was noted (figure 6). Much of the 2007 treatment for milfoil took place in the Crystal Bay and Crystal Cove channel system in the northwest part of the lake. This area was a primary location for Eurasian watermilfoil growth as a result of being excluded from the fluridone treatment in 2006. Hamilton Lake's treatment history is summarized in table 1 below.

Acres of Treatment per Year	Eurasian watermilfoil, 2,4-D	Low-dose Curlyleaf pondweed	Priority area shoreline treatment Eurasian milfoil & problem natives, contact herbicides	Whole Lake Treatment for Eurasian watermilfoil (fluridone granular)	Acres of Eurasian watermilfoil Untreated	Acres of Curlyleaf pondweed Untreated	Funding
1998	81	0	30	-	153	0	
1999	110	40	55	-	99	0	
2000	93	60	61	-	110	0	
2001	0	0	180	-	84	0	
2002	139.25	0	56	-	100+	0	HLA
2003	0	0	0	264 (all E. milfoil & Curlyleaf treated)	0	0	HLA
2004	1.5	65	2	-	0	0	HLA
2005	45	0	0	-	0	0	HLA/LARE
2006	0	0	0	264 (all E. milfoil & Curlyleaf treated)	0	0	HLA/LARE
2007	6	144.5	0	0	0	25.5	HLA/LARE

Table 1 Plant Management Activities since 2002 on Hamilton Lake

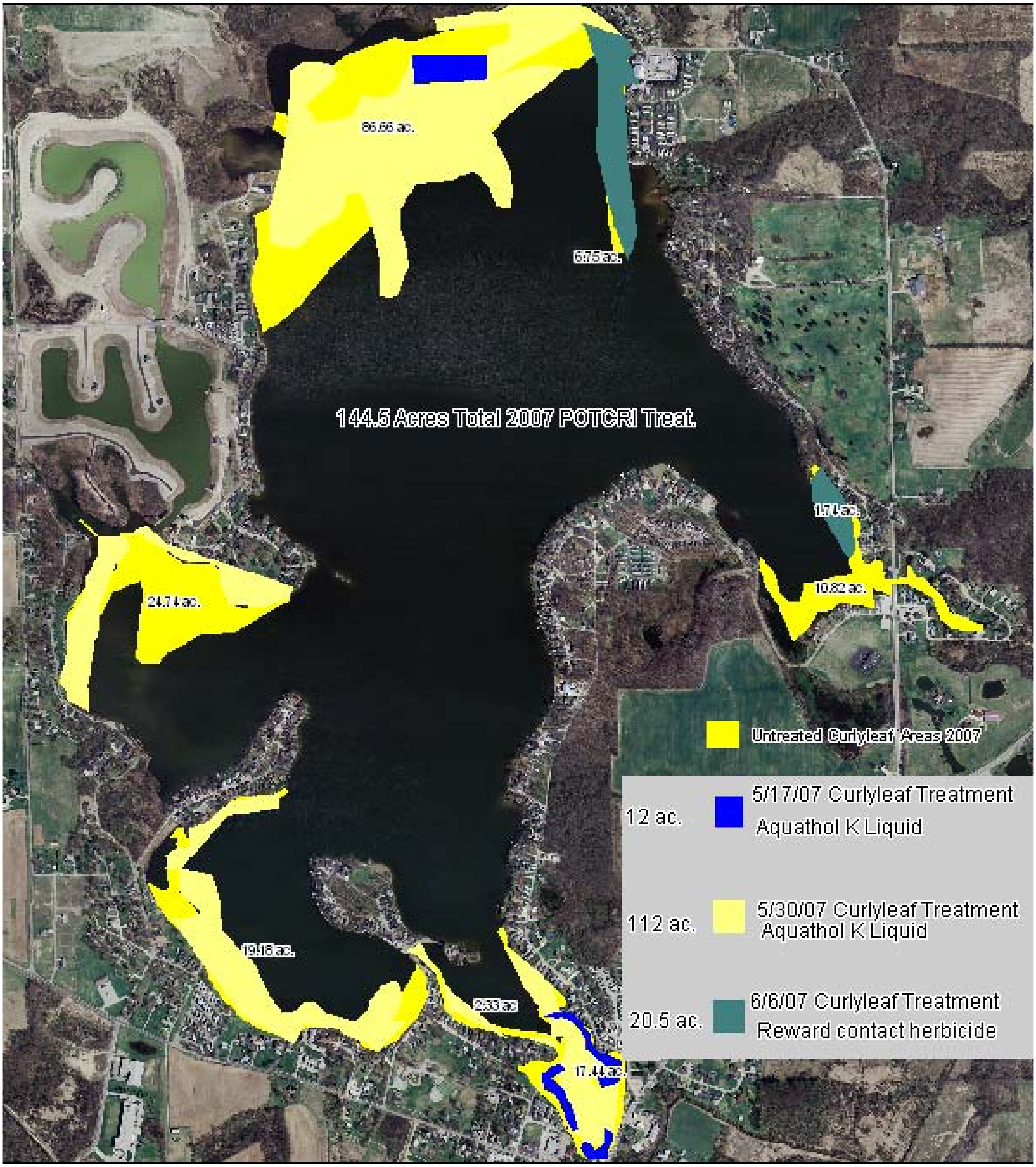


Figure 5 2007 Season Curlyleaf pondweed Treatment Areas (and 2007 Curlyleaf pondweed distribution map) for Hamilton Lake

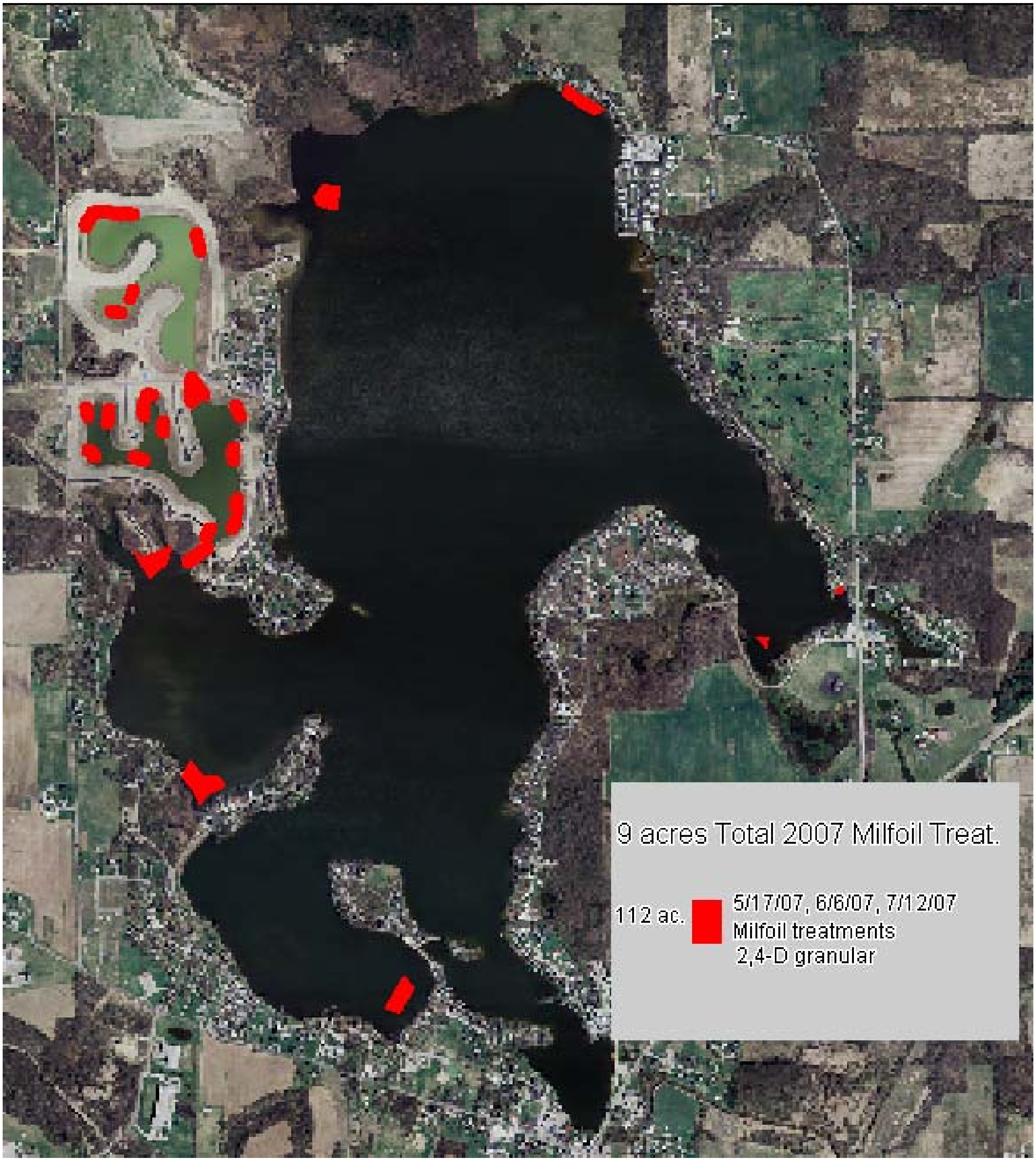


Figure 6 2007 Season Eurasian watermilfoil treatment areas (and Eurasian watermilfoil milfoil distribution map) for Hamilton Lake; all areas of growth were treated.

8.0 Aquatic Plant Community Characterization

8.1 Methods

Two primary methods of observation were used to characterize the lake's plant community during the 2007 season. Exotic plant beds were mapped mainly by visual observation. Extensive time was spent running a zigzag pattern over the lake's littoral zone to establish the boundaries for dense exotic plant growth. This was complimented by Tier II quantitative survey plant collection data, prior knowledge of the lake's typical plant growth pattern, a contour map, and season-long input from the lake association. A handheld WAAS Enabled GPS unit was also helpful in marking the general boundaries of exotic plantbeds for mapping. To characterize the lake's plant community quantitatively and produce objective data for analysis and tracking of overall plant community composition, Tier II Plant surveys were utilized as described in the next section.

8.1.1 Tier II

Tier II stratified random sampling was utilized on June 5, 6 and August 12 of 2007 to establish random stratified plant sampling points and quantify approximate species biomass at each respective point. The Tier II aquatic plant sampling protocol was established by INDR and is available in full in *Tier II Aquatic Vegetation Survey Protocol, May 2007* (IDNR 2007). In Tier two sampling, data collection points are established within given depth strata of the lake according to lake size and trophic status listing. For Hamilton Lake a "Eutrophic" or high nutrient status and surface area of 802 acres were used. Sampling was performed to a depth of 15 feet. A toss of a specially fabricated two sided rake (figure 7) on a rope is used to sample vegetation from the lake bottom at each point. After retrieval of the rake a score is assigned to each recovered plant species by separating the species and placing them back on the rake. The thickness of the plants when placed back on the rake is recorded as measured by equally spaced marks on the rake tines. This measurement assigns a rake score of one, three, or five to each species as a basic measure of biomass. Plants seen but not recovered on the rake are marked as "observed only". Filamentous algae is recorded only as "present" if recovered on the rake. Location data for sampling points was collected using a WAAS enabled GPS unit. Data points were then downloaded to geographic information system (GIS) software for placement on a map. Because aquatic plant species vary in their prominence during various parts of the growing season sampling is performed in both the late and early season during plant plan development. During treatment seasons the two-survey regime can also allow for a pre-treatment and post-treatment comparison of the lake's plant community. Data collected during the Tier II survey is then used to calculate a set of statistical descriptors developed by IDNR to help characterize plant communities in Indiana waters (Pearson 2004) The 100 Tier II sampling points for the two Hamilton Lake surveys in 2007 are displayed in figures 8 and 9 below.

Figure 7 Tier II Plant Sampling Rake

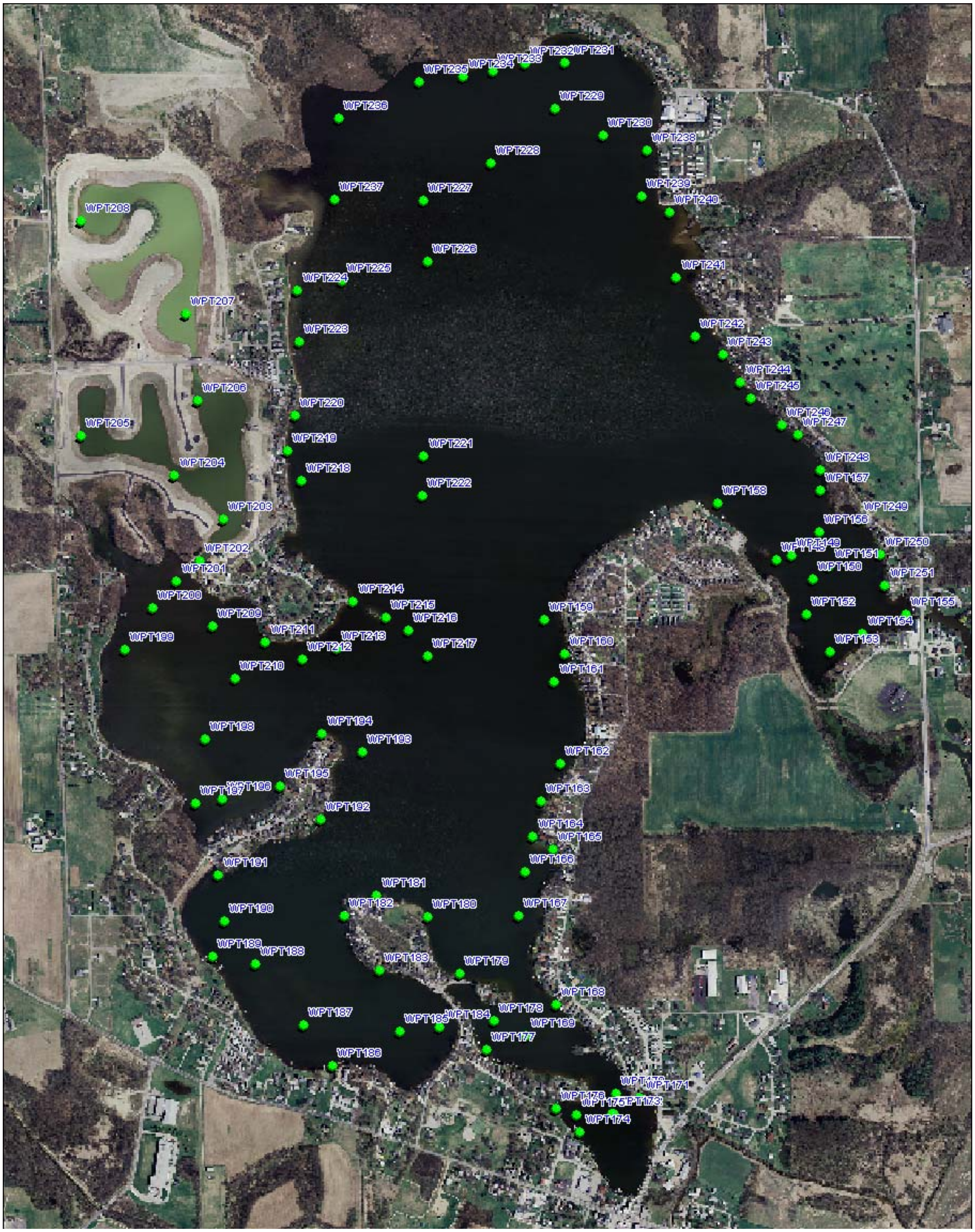


Figure 8 June 5 and 6, 2007 Tier II Sampling Points for Hamilton Lake

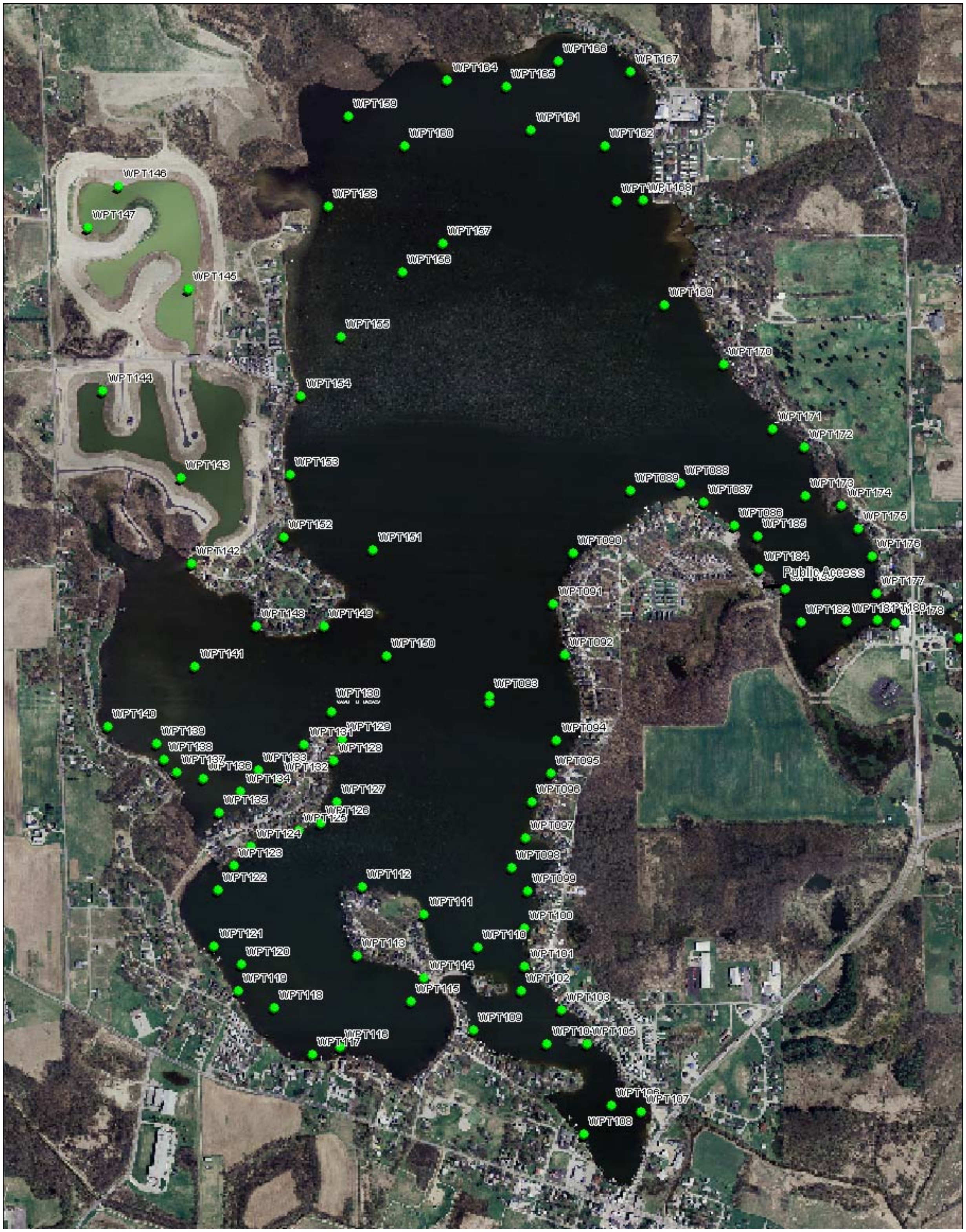


Figure 9 August 12, 2007 Tier II Sampling Points for Hamilton Lake

8.2 Results

8.2.1 Tier II

Macrophyte Inventory Discussion

The two tables below contain plant community descriptors for the early and late season Tier II surveys. Descriptors from a set of 21 other Indiana Lakes (Pearson 2004) are provided to provide insight into how the Hamilton Lake plant community compares to that of other Indiana Lakes. Tables 6-13 below show all the tier II data including data specific to each five-foot depth contour zone. With 13 species noted (August Survey), Hamilton has significantly more species of plants than the average of eight species for the 21 lake set. The number of native species, number of species per site, and Species diversity index are all above the 21 lake average showing a relatively diverse and healthy plant community for Hamilton Lake. Beds of Richardson's pondweed, a state "rare" plant were identified growing in several areas of Crystal Bay and Crystal Cove. No voucher specimens were collected. This plant was not seen Outside the Crystal Subdivision channels. Water clarity at Hamilton Lags somewhat compared to many area lakes of comparable size (6 feet Secchi in June and 4 feet in August of 2007), but the lake continues to maintain a thriving native plant community. Aquatic plants were recovered from a maximum depth of 11 feet in the May survey (Chara *Chara sp.* and Eurasian watermilfoil) and a maximum depth of 10.1 feet in the June survey (Curlyleaf, Chara, and Eurasian watermilfoil). Based on the maximum depth of plant growth in 2007 the approximate area of Hamilton's littoral zone is 477 acres. The area of growth was mapped in 2007 for the two invasive non-native species present and served to help direct chemical treatment in 2007. Figure 6 above serves as the map for the observed areas of Eurasian watermilfoil growth in the 2007 season. Figure 5 above shows the area of significant Curlyleaf pondweed growth. Both figures also indicate 2007 treatment areas for these plants.

Figures 10-18 below show the distribution of the most common plant species collected in the two Tier II surveys. The Eurasian watermilfoil occurrence was only three percent in both the early and late season surveys, showing that this plant has all but been eliminated by the whole lake treatment in 2006. Only one Eurasian milfoil plant was collected outside of Crystal Bay and Crystal cove during the surveys, suggesting that this area (which was not part of the 2006 fluridone treatment) probably provided a refuge to this species. The occurrence of Curlyleaf pondweed was extremely high during the June Survey with Curlyleaf sampled at 69 percent of sites. It was the most common plant in the early season survey. Due to treatments and the natural tendency for Curlyleaf to die-back in the late season it was only found at 11 percent of sites in the August survey. Obviously Curlyleaf presented a much larger problem for lake users in 2007 than Eurasian watermilfoil. As the program for control for exotic plants is continued at Hamilton Lake it would be reasonable to establish a goal of holding Eurasian watermilfoil at an occurrence of five percent or less in the late season sampling, while a realistic goal for Curlyleaf reduction might be five percent or less in a late season survey.

Plant colonization patterns on Hamilton Lake in general show a relationship to the nutrient and sediment inputs from the lake's tributaries. Major areas of growth for both native and invasive species correspond roughly to the Curlyleaf pondweed treatment areas in figure five above and include the 87 acre littoral shelf at the lake's north end, a 30 acre littoral area along the north and west shorelines of Muskrat Bay, the shorelines of Fee Lake, the lake's east bay near the public access, and the 20 acre area in and around the millpond basin. Curlyleaf pondweed and Coontail *Ceratophyllum demersum* appeared to prefer more nutrients or a richer hydrosoil and grew more thickly near delta areas. Native plants like Slender naiad *Najas flexilis* and Flatstem pondweed *Potamogeton zosteriformis* seem to have occurred along the less fertile sandier main basin shorelines just as much as in the backwater and tributary areas. Both fertility and competition with non-natives have probably shaped this tendency to some extent, but it demonstrates that exotics may be less likely to invade less fertile areas of the lake. Continuing with steps to reduce nutrient and sediment input from Hamilton Lake's tributaries will be beneficial to plant management in the long term. Variable watermilfoil *Myriophyllum heterophylum* and Richardson's pondweed were seen growing exclusively at Crystal Bay and Crystal Cove. These plants should be considered beneficial at Hamilton Lake, providing habitat not present on Hamilton Lake proper. They should be preserved when possible by limiting competition with invasives in this area, tailoring pesticide applications appropriately, and enforcing limits on watercraft speed in this area.

Descriptor	**Hamilton 6/9/07**	**range for 21 other Indiana lakes**	**mean for 21 other Indiana lakes**
# Sampling sites	100		
Total number of species	12	1 to 17	8
Total number of native species	10	1 to 16	7
Mean number of species per site	1.68	.38 to 2.66	1.61
Species diversity index (SDI), 0-1 scale	.75	0.0 to .91	0.66
Aquatic Vegetation % frequency of Occurrence	87		
Secchi Depth	6		
Eurasian watermilfoil % Frequency of Occurrence	3		
Curlyleaf pondweed % Frequency of Occurrence	69		

Table 2 Plant Community Descriptors from the 8/9/07 Tier II Survey

Descriptor	**Hamilton 8/12/07**	**range for 21 other Indiana lakes**	**mean for 21 other Indiana lakes**
# Sampling sites	100		
Total number of species	13	1 to 17	8
Total number of native species	11	1 to 16	7
Mean number of species per site	1.87	.38 to 2.66	1.61
Species diversity index (SDI), 0-1 scale	.86	0.0 to .91	0.66
Aquatic Vegetation % frequency of Occurrence	82		
Secchi Depth	4		
Eurasian watermilfoil % Frequency of Occurrence	3		
Curlyleaf pondweed % Frequency of Occurrence	11		

Table 3 Plant Community Descriptors from the 8/9/07 Tier II Survey

Occurrence and Abundance of Submersed Aquatic Plants - Overall							
Lake: Hamilton		Secchi(ft): 6.0		SE Mean species / site: 0.11			
Date: 6/5,6/07		Littoral sites with plants: 87		Mean natives / site: 0.96			
Littoral Depth (ft): 13.0		Number of species: 12		SE Mean natives / site: 0.09			
Littoral Sites: 97		Maximum species / site: 4		Species diversity: 0.75			
Total Sites: 100		Mean species / site: 1.68		Native diversity: 0.76			
		Frequency of	Score Frequency				
Species		Occurrence	0	1	3	5	Dominance
POTCRI Curly leaf		69.0	31.0	34.0	16.0	19.0	35.4
CERDEM Coontail		36.0	64.0	30.0	3.0	3.0	10.8
POTZOS Fltstem pondweed		20.0	80.0	19.0	1.0	0.0	4.4
CHAR Chara		18.0	82.0	15.0	2.0	1.0	5.2
STUPEC Sago pondweed		12.0	88.0	10.0	1.0	1.0	3.6
MYRSPI Eurasian milfoil		3.0	97.0	2.0	0.0	1.0	1.4
POTRIC Richardson's pdwd		3.0	97.0	3.0	0.0	0.0	0.6
POTAMP Lglf pondweed		2.0	98.0	1.0	1.0	0.0	0.8
POTPUP Small pondweed		2.0	98.0	2.0	0.0	0.0	0.4
NAJFLE Slender naiad		1.0	99.0	1.0	0.0	0.0	0.2
RANLON Wt-wtr crowfoot		1.0	99.0	1.0	0.0	0.0	0.2
ZOSDUB Water stargrass		1.0	99.0	1.0	0.0	0.0	0.2

Table 4 Overall Tier II Plant Data for the June Survey

Occurrence and Abundance of Submersed Aquatic Plants - 0 to 5 ft.							
Lake: Hamilton		Secchi(ft): 6.0		SE Mean species / site: 0.15			
Date: 6/5,6/07		Littoral sites with plants: 50		Mean natives / site: 1.00			
Littoral Depth (ft): 13.0		Number of species: 12		SE Mean natives / site: 0.13			
Littoral Sites: 59		Maximum species / site: 4		Species diversity: 0.78			
Total Sites: 59		Mean species / site: 1.59		Native diversity: 0.78			
		Frequency of	Score Frequency				
Species		Occurrence	0	1	3	5	Dominance
POTCRI Curly leaf		57.6	42.4	32.2	15.3	10.2	25.8
CERDEM Coontail		32.2	67.8	28.8	0.0	3.4	9.2
CHAR Chara		23.7	76.3	20.3	1.7	1.7	6.8
POTZOS Fltstem pondweed		22.0	78.0	22.0	0.0	0.0	4.4
STUPEC Sago pondweed		8.5	91.5	6.8	1.7	0.0	2.4
POTRIC Richardson's pdwd		5.1	94.9	5.1	0.0	0.0	1.0
POTAMP Lglf pondweed		1.7	98.3	0.0	1.7	0.0	1.0
MYRSPI Eurasian milfoil		1.7	98.3	1.7	0.0	0.0	0.3
NAJFLE Slender naiad		1.7	98.3	1.7	0.0	0.0	0.3
POTPUP Small pondweed		1.7	98.3	1.7	0.0	0.0	0.3
RANLON Wt-wtr crowfoot		1.7	98.3	1.7	0.0	0.0	0.3
ZOSDUB Water stargrass		1.7	98.3	1.7	0.0	0.0	0.3

Table 5 0-5 Foot Contour Plant Data for the June Survey

Occurrence and Abundance of Submersed Aquatic Plants - 5 to 10 ft.

Lake:	Hamilton	Secchi(ft):	6.0	SE Mean species / site:	0.10
Date:	6/5,6/07	Littoral sites with plants:	32	Mean natives / site:	0.97
Littoral Depth (ft):	13.0	Number of species:	7	SE Mean natives / site:	0.11
Littoral Sites:	32	Maximum species / site:	3	Species diversity:	0.69
Total Sites:	32	Mean species / site:	1.94	Native diversity:	0.70

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
POTCRI Curly leaf	93.8	6.3	40.6	18.8	34.4	53.8
CERDEM Coontail	43.8	56.3	34.4	6.3	3.1	13.8
STUPEC Sago pondweed	21.9	78.1	18.8	0.0	3.1	6.9
POTZOS Fltstem pondweed	18.8	81.3	15.6	3.1	0.0	5.0
CHAR Chara	9.4	90.6	9.4	0.0	0.0	1.9
MYRSPI Eurasian milfoil	3.1	96.9	3.1	0.0	0.0	0.6
POTPUP Small pondweed	3.1	96.9	3.1	0.0	0.0	0.6
NAJFLE Slender naiad	0.0	100.0	0.0	0.0	0.0	0.0

Table 6 5-10 Foot Contour Plant Data for the June Survey

Occurrence and Abundance of Submersed Aquatic Plants - 10 to 15 ft.

Lake:	Hamilton	Secchi(ft):	6.0	SE Mean species / site:	0.47
Date:	6/5,6/07	Littoral sites with plants:	5	Mean natives / site:	0.67
Littoral Depth (ft):	13.0	Number of species:	6	SE Mean natives / site:	0.29
Littoral Sites:	6	Maximum species / site:	3	Species diversity:	0.74
Total Sites:	9	Mean species / site:	1.33	Native diversity:	0.67

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
POTCRI Curly leaf	55.6	44.4	22.2	11.1	22.2	33.3
CERDEM Coontail	33.3	66.7	22.2	11.1	0.0	11.1
MYRSPI Eurasian milfoil	11.1	88.9	0.0	0.0	11.1	11.1
CHAR Chara	11.1	88.9	0.0	11.1	0.0	6.7
POTAMP Lglf pondweed	11.1	88.9	11.1	0.0	0.0	2.2
POTZOS Fltstem pondweed	11.1	88.9	11.1	0.0	0.0	2.2
NAJFLE Slender naiad	0.0	100.0	0.0	0.0	0.0	0.0

Table 7 10-15 Foot Contour Plant Data for the June Survey

Occurrence and Abundance of Submersed Aquatic Plants - Overall		
Lake: Hamilton	Secchi(ft): 4.0	SE Mean species / site: 0.14
Date: 8/12/2007	Littoral sites with plants: 82	Mean natives / site: 1.65
Littoral Depth (ft): 11.0	Number of species: 13	SE Mean natives / site: 0.13
Littoral Sites: 93	Maximum species / site: 6	Species diversity: 0.86
Total Sites: 100	Mean species / site: 1.87	Native diversity: 0.83

Species	Frequency of Occurrence	Score Frequency 0	1	3	5	Dominance
CERDEM Coontail	43.0	57.0	15.0	7.0	21.0	28.2
NAJFLE Slender naiad	30.0	70.0	27.0	1.0	2.0	8.0
STUPEC Sago pondweed	28.0	72.0	13.0	7.0	8.0	14.8
ZOSDUB Water stargrass	23.0	77.0	14.0	3.0	6.0	10.6
POTZOS Fltstem pondweed	18.0	82.0	15.0	1.0	2.0	5.6
CHAR Chara	13.0	87.0	13.0	0.0	0.0	2.6
POTCRI Curly leaf	11.0	89.0	7.0	2.0	2.0	4.6
NAJMIN Brittle naiad	8.0	92.0	8.0	0.0	0.0	1.6
POTPUP Small pondweed	4.0	96.0	4.0	0.0	0.0	0.8
MRYSPI Eurasian milfoil	3.0	97.0	1.0	1.0	1.0	1.8
POTAMP Lglf pondweed	2.0	98.0	2.0	0.0	0.0	0.4
POTRIC Richardson's pdwd	2.0	98.0	2.0	0.0	0.0	0.4
UTRMAC Great Bladderwort	1.0	99.0	1.0	0.0	0.0	0.2
ZANPAL Horned pondweed	1.0	99.0	1.0	0.0	0.0	0.2

Table 8 Overall Plant Data for the August Survey

Occurrence and Abundance of Submersed Aquatic Plants - 0 to 5 ft.		
Lake: Hamilton	Secchi(ft): 4.0	SE Mean species / site: 0.19
Date: 8/12/2007	Littoral sites with plants: 53	Mean natives / site: 1.93
Littoral Depth (ft): 11.0	Number of species: 12	SE Mean natives / site: 0.17
Littoral Sites: 57	Maximum species / site: 6	Species diversity: 0.86
Total Sites: 57	Mean species / site: 2.11	Native diversity: 0.84

Species	Frequency of Occurrence	Score Frequency 0	1	3	5	Dominance
NAJFLE Slender naiad	43.9	56.1	38.6	1.8	3.5	12.3
CERDEM Coontail	42.1	57.9	15.8	8.8	17.5	26.0
STUPEC Sago pondweed	28.1	71.9	17.5	1.8	8.8	13.3
ZOSDUB Water stargrass	28.1	71.9	19.3	3.5	5.3	11.2
POTZOS Fltstem pondweed	21.1	78.9	15.8	1.8	3.5	7.7
CHAR Chara	19.3	80.7	19.3	0.0	0.0	3.9
NAJMIN Brittle naiad	8.8	91.2	8.8	0.0	0.0	1.8
POTCRI Curly leaf	7.0	93.0	3.5	1.8	1.8	3.5
POTPUP Small pondweed	3.5	96.5	3.5	0.0	0.0	0.7
POTRIC Richardson's pdwd	3.5	96.5	3.5	0.0	0.0	0.7
MRYSPI Eurasian milfoil	1.8	98.2	0.0	1.8	0.0	1.1
POTAMP Lglf pondweed	1.8	98.2	1.8	0.0	0.0	0.4
UTRMAC Great Bladderwort	1.8	98.2	1.8	0.0	0.0	0.4

Table 9 0-5 Foot Plant Data for the August Survey

Occurrence and Abundance of Submersed Aquatic Plants - 5 to 10 ft.									
Lake:	Hamilton	Secchi(ft):	4.0	SE Mean species / site:	0.22				
Date:	8/12/2007	Littoral sites with plants:	28	Mean natives / site:	1.64				
Littoral Depth (ft):	11.0	Number of species:	11	SE Mean natives / site:	0.19				
Littoral Sites:	33	Maximum species / site:	4	Species diversity:	0.84				
Total Sites:	33	Mean species / site:	1.97	Native diversity:	0.79				

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
CERDEM Coontail	57.6	42.4	18.2	6.1	33.3	40.6
STUPEC Sago pondweed	36.4	63.6	9.1	18.2	9.1	21.8
ZOSDUB Water stargrass	21.2	78.8	9.1	3.0	9.1	12.7
POTCRI Curly leaf	21.2	78.8	15.2	3.0	3.0	7.9
POTZOS Fltstem pondweed	18.2	81.8	18.2	0.0	0.0	3.6
NAJFLE Slender naiad	15.2	84.8	15.2	0.0	0.0	3.0
NAJMIN Brittle naiad	9.1	90.9	9.1	0.0	0.0	1.8
POTPUP Small pondweed	6.1	93.9	6.1	0.0	0.0	1.2
CHAR Chara	3.0	97.0	3.0	0.0	0.0	0.6
MRYSPI Eurasian milfoil	3.0	97.0	3.0	0.0	0.0	0.6
POTAMP Lglf pondweed	3.0	97.0	3.0	0.0	0.0	0.6
ZANPAL Horned pondweed	3.0	97.0	3.0	0.0	0.0	0.6

Table 10 5-10 Foot Plant Data for the August Survey

Occurrence and Abundance of Submersed Aquatic Plants - 10 to 15 ft.									
Lake:	Hamilton	Secchi(ft):	4.0	SE Mean species / site:	0.20				
Date:	8/12/2007	Littoral sites with plants:	1	Mean natives / site:	0.10				
Littoral Depth (ft):	11.0	Number of species:	2	SE Mean natives / site:	0.10				
Littoral Sites:	3	Maximum species / site:	2	Species diversity:	0.50				
Total Sites:	10	Mean species / site:	0.20	Native diversity:	0.00				

	Frequency of	Score Frequency				
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
MRYSPI Eurasian milfoil	10.0	90.0	0.0	0.0	10.0	10.0
CHAR Chara	10.0	90.0	10.0	0.0	0.0	2.0
CERDEM Coontail	0.0	100.0	0.0	0.0	0.0	0.0
NAJFLE Slender naiad	0.0	100.0	0.0	0.0	0.0	0.0
NAJMIN Brittle naiad	0.0	100.0	0.0	0.0	0.0	0.0

Table 11 10-15 Foot Plant Data for the August Survey

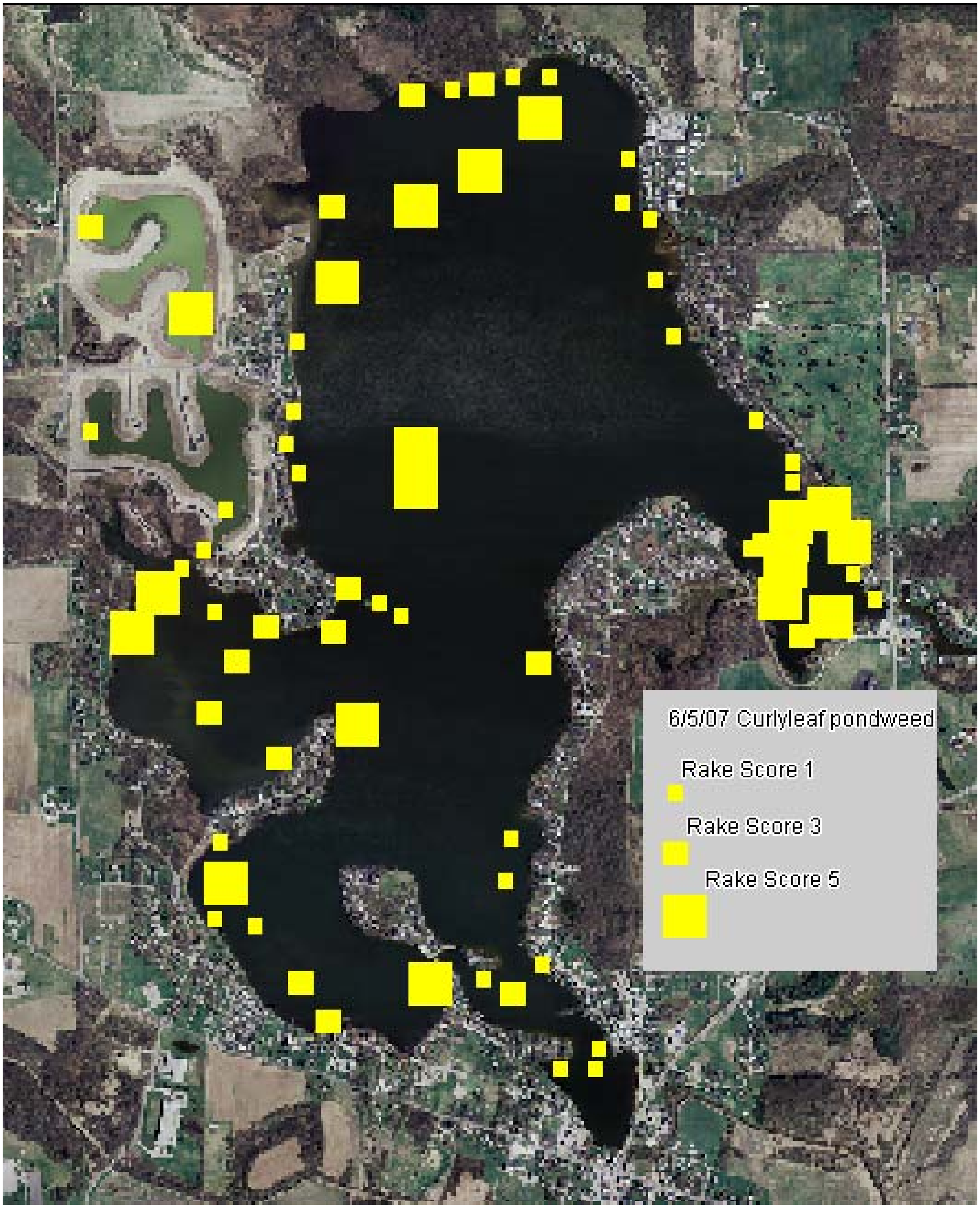


Figure 10 Curlyleaf pondweed Map for the 6/5/07 Tier II

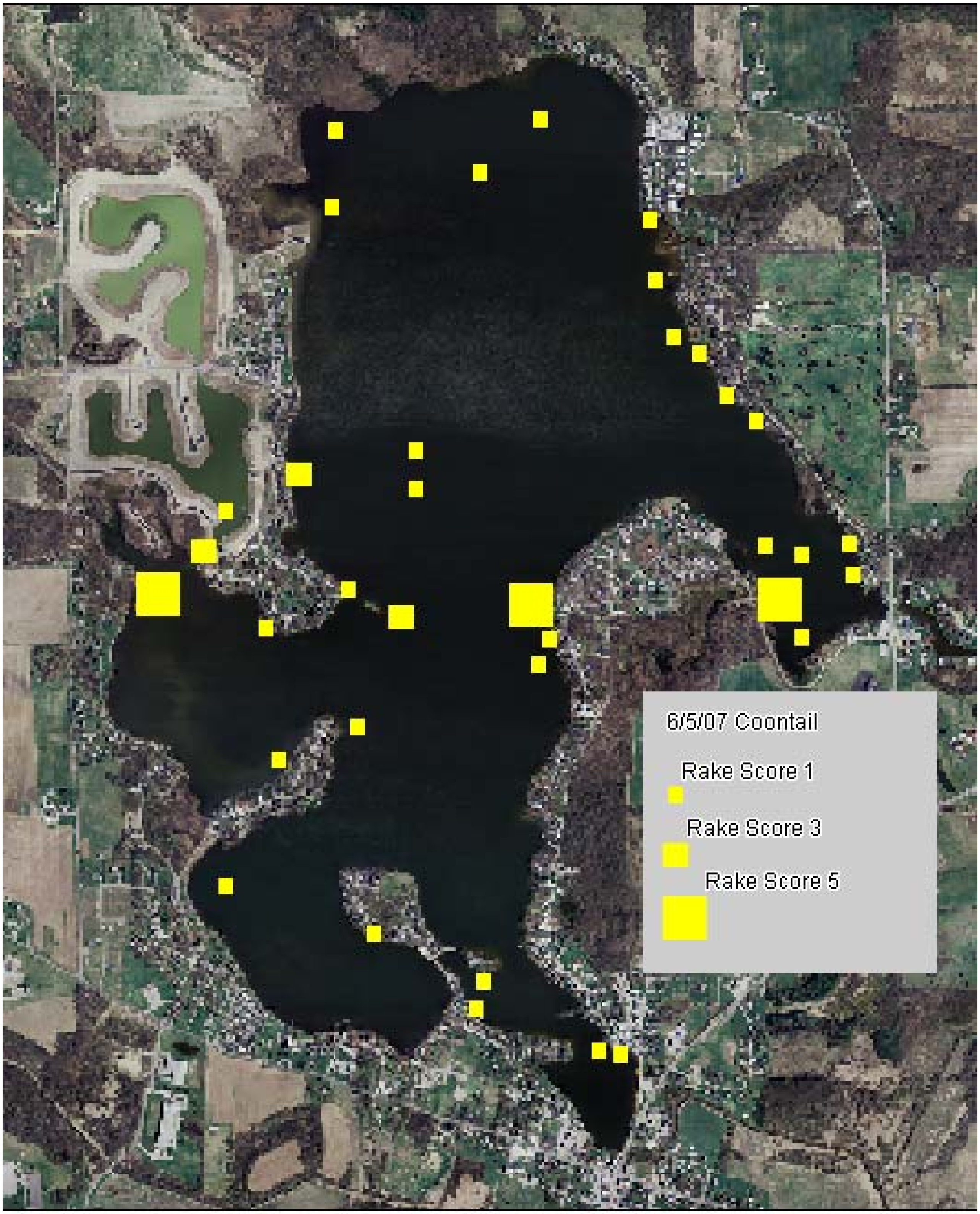


Figure 11 Coontail Map for the 6/5/07 Tier II

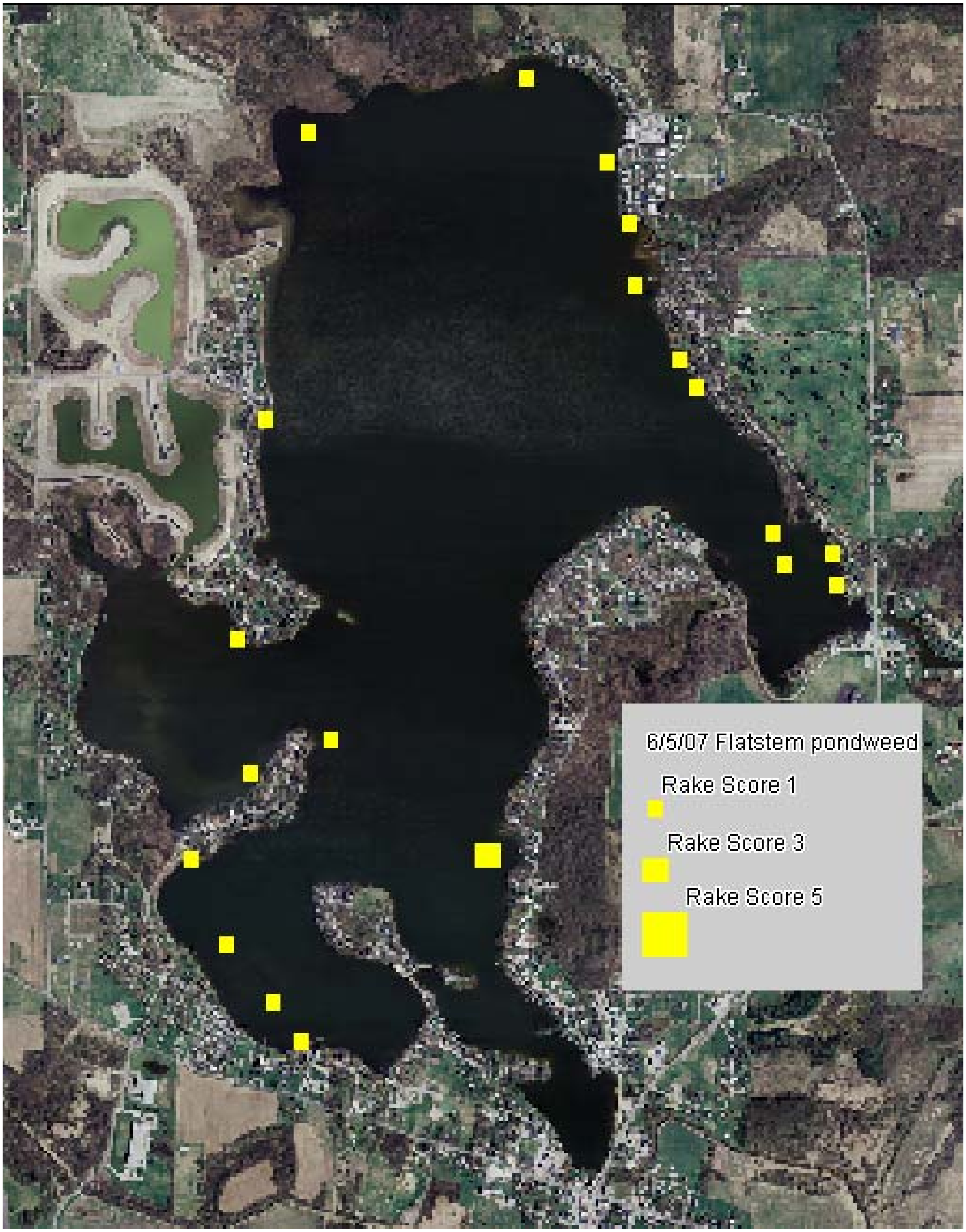


Figure 12 Flatstem pondweed Map for the 6/5/07 Tier II

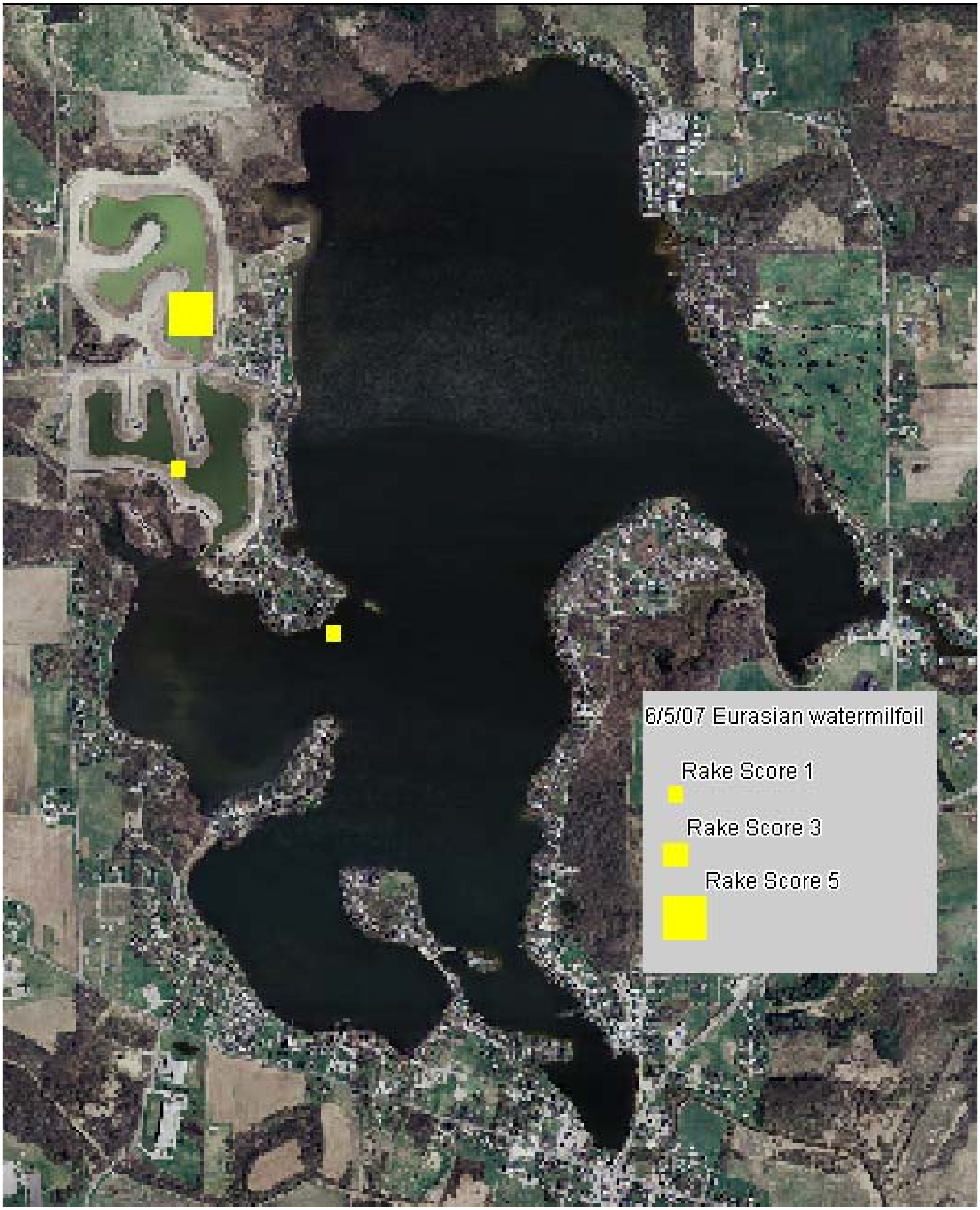


Figure 13 Eurasian watermilfoil Map for the 6/5/07 Tier II

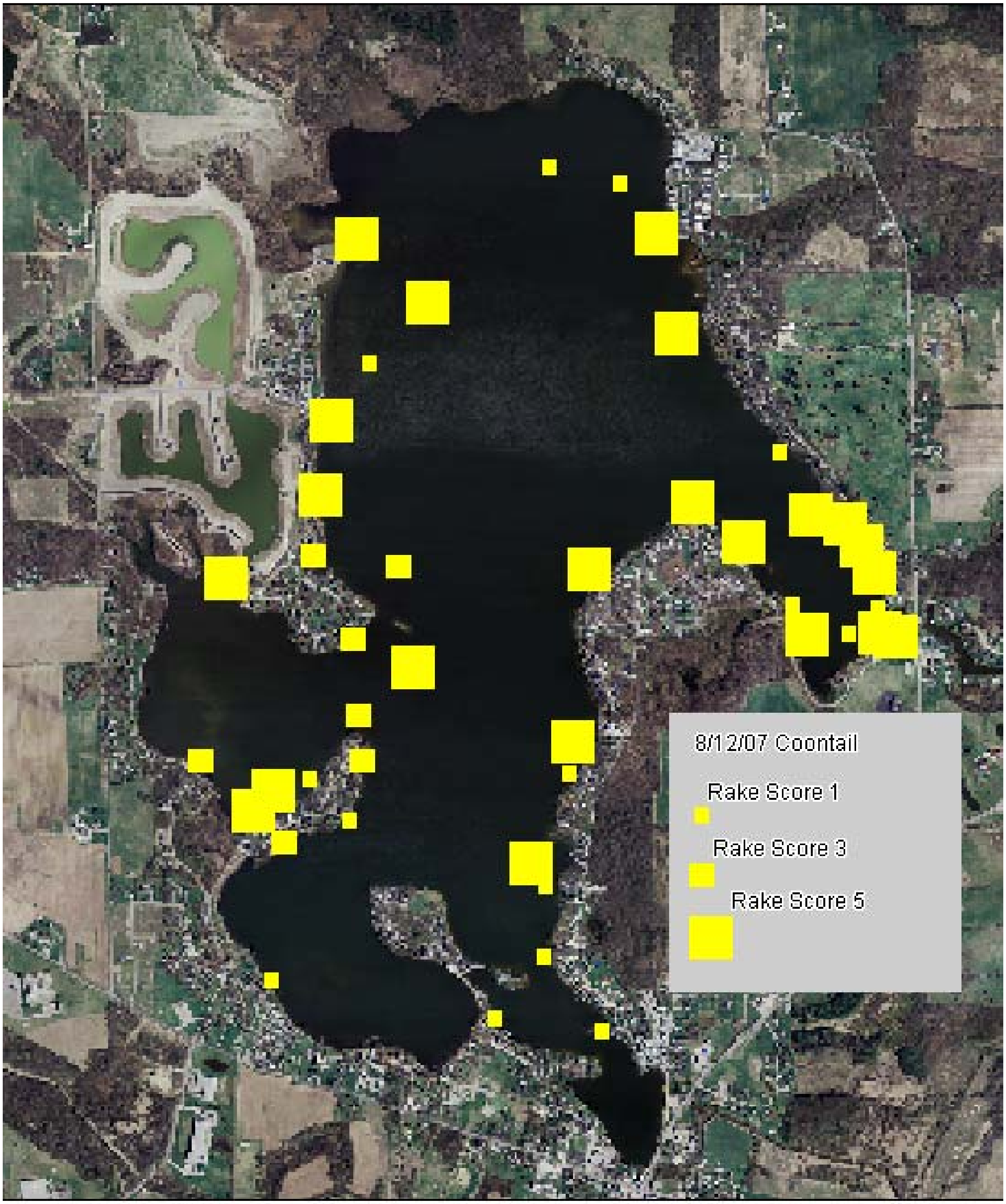


Figure 14 Coontail Map for the 8/12/07 Tier II

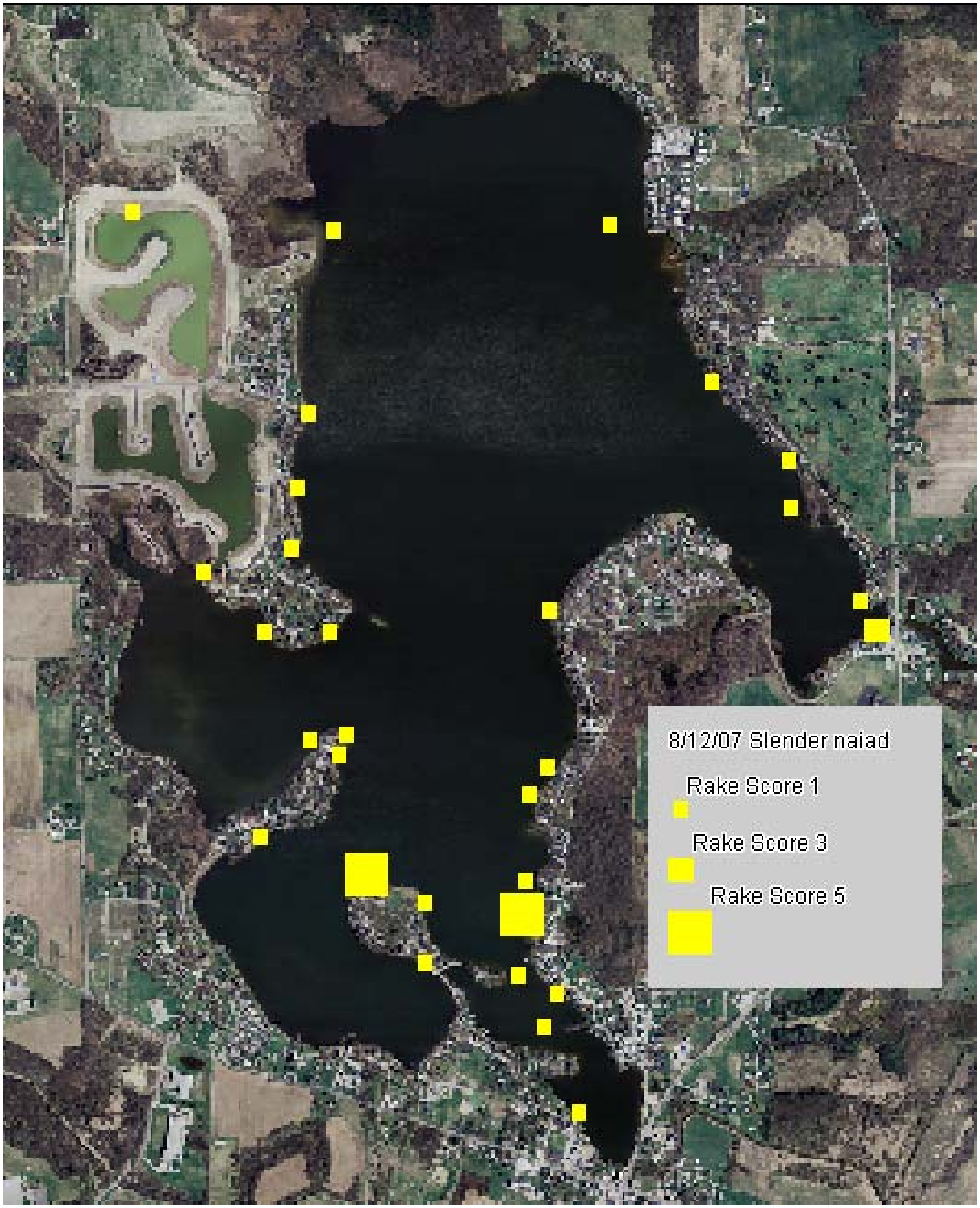


Figure 15 Slender naiad Map for the 8/12/07 Tier II

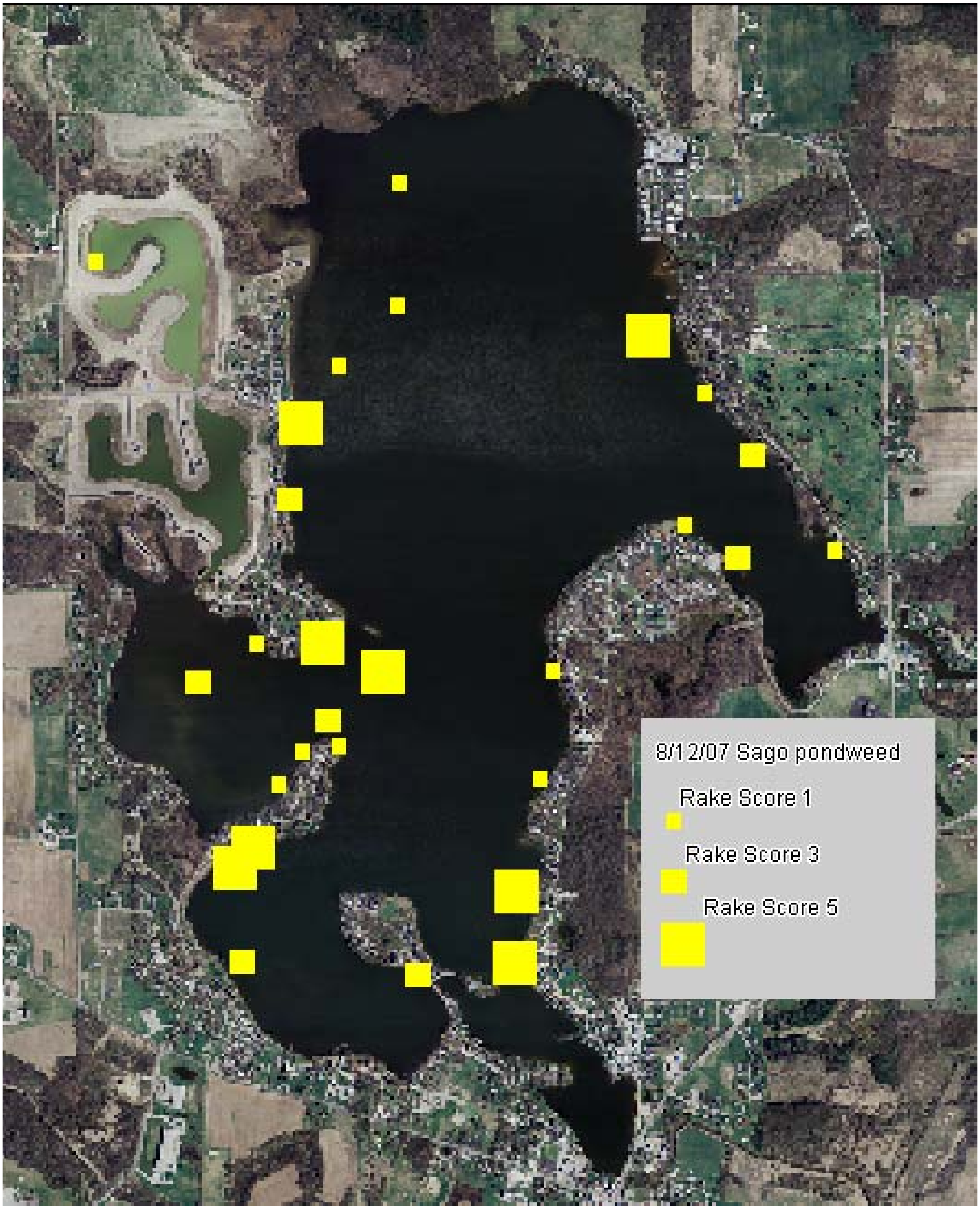


Figure 16 Sago pondweed Map for the 8/12/07 Tier II

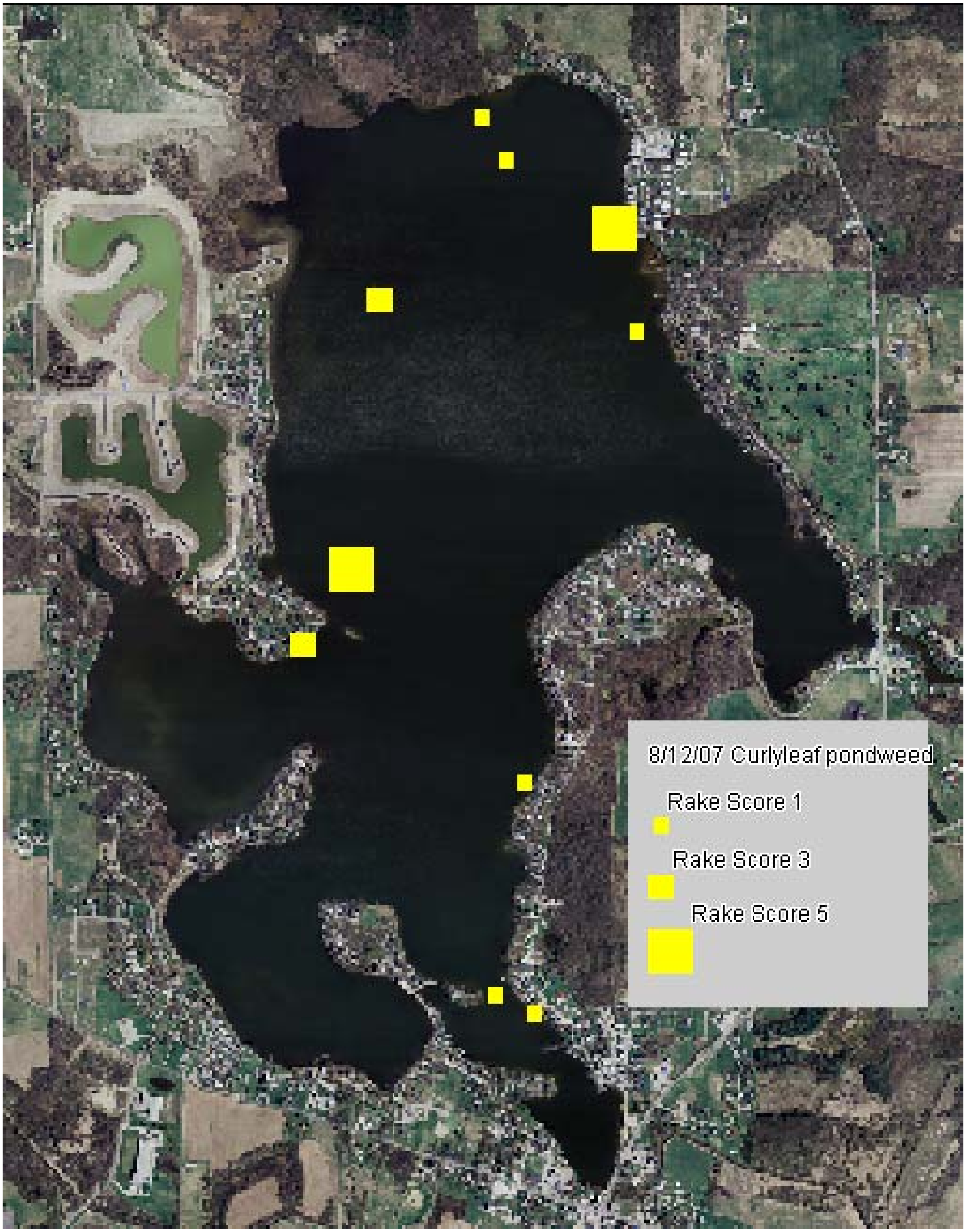


Figure 17 Curlyleaf pondweed Map for the 8/12/07 Tier II

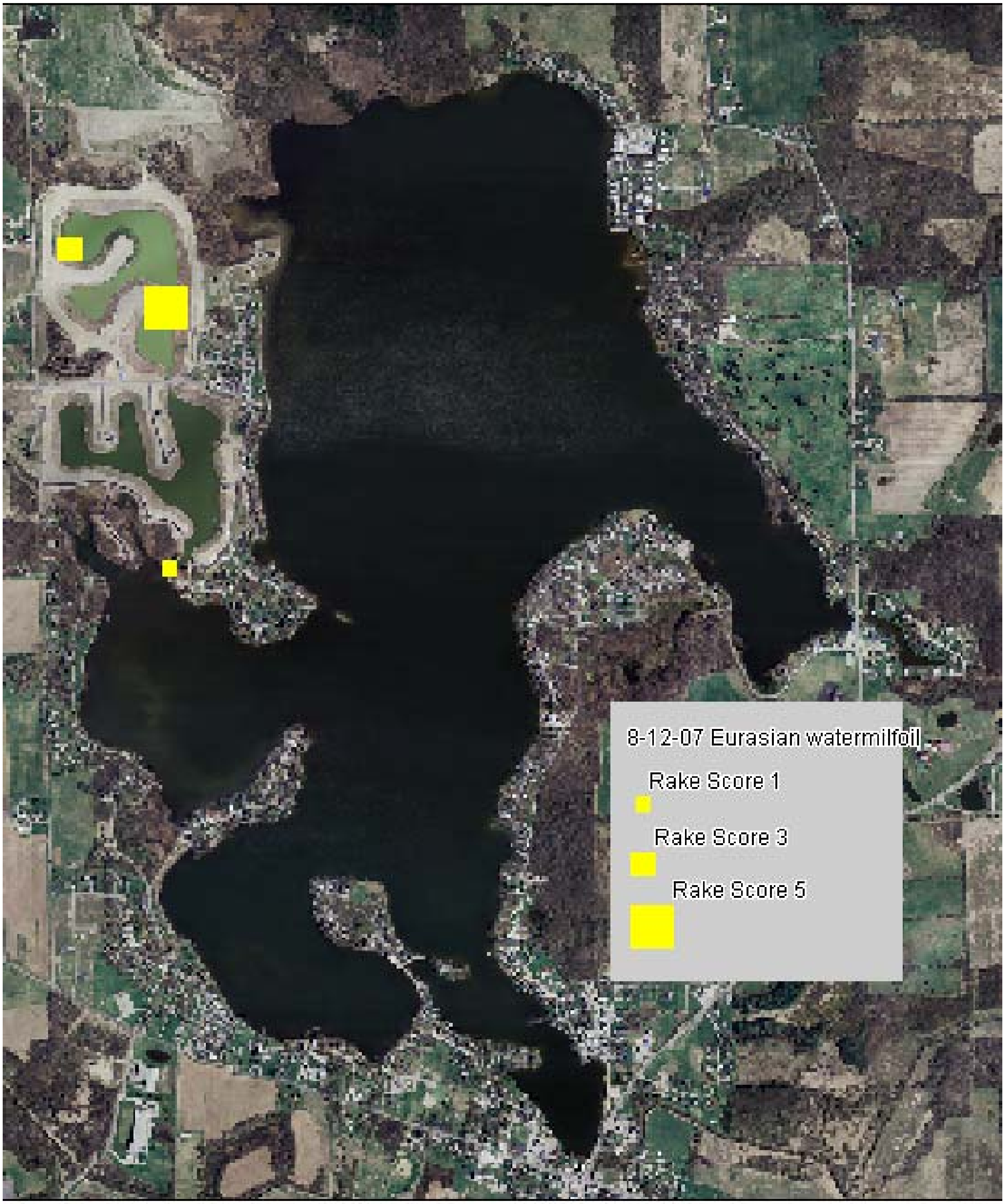


Figure 18 Eurasian watermilfoil Map for the 8/12/07 Tier II

9.0 Aquatic Vegetation Management Alternatives
General Options for Controlling Invasive Exotic Aquatic Plants

•Insect Biological Control:
A North American Weevil *Euhrychiopsis lecontie,* may be associated with natural declines in Eurasian milfoil at northern lakes (Sheldon 1994, Bratager et al. 1996, Weinberg 1995). In recent years the weevils have been marketed and stocked as a biological control agent with varying results. Historically associated with the native milfoils, the insects are capable of grazing on Eurasian milfoil as well, while not affecting the majority of native vegetation. A control program involves breeding the weevils in captivity, collecting them and then physically attaching the insects to the target plants in the field. The stocked weevils sometimes produce a modest reduction in milfoil biomass among targeted plants during the first season. In most cases restocking must occur every year to maintain control, in many cases no reduction in plants is noted at all after stocking. Interest in the use of the milfoil weevils has been high. They are often viewed as a natural control method that will be less environmentally damaging than more effective forms of control. At present, the high cost and relatively low reductions in plant biomass associated with weevil stocking programs has severely limited their popularity as a control mechanism.

•Harvesting:
There are several models of machines produced for cutting and removal of aquatic vegetation from lakes. Contractors who own the machines generally hire on to cut plants on an hourly basis with organizations that can provide a set minimum hours of work to cover mobilization costs. Most harvesters are constructed like a floating combine. The floating machine is driven and steered with paddle wheels. An underwater cutting bar cuts plant stems and a driven belt carries the cuttings to the back of the machine where they are deposited in a hopper. When the machines hopper is full the machine operator offloads the aquatic cuttings in a designated area or into the back of a truck for disposal. One advantage of harvesting is the actual removal of plant material and associated nutrients from the lake. Unfortunately, only a very small percentage of a lakes nutrient load is invested in plant biomass at any given time. In most cases the cutting will have to be repeated each season and often multiple cuttings per season are needed to control plant regrowth. A major disadvantage of harvesters is the amount of biological disturbance introduced to the lake during the cutting process. Eurasian watermilfoil maintains the ability to recover very quickly from cutting. Native plants which cannot recover as readily from the harvesting encounter a selective disadvantage. The end result can be a shift in plant biomass away from more beneficial native plants, toward Eurasian watermilfoil. Whereas Eurasian milfoil can reproduce through fragmentation, the potential for free floating cut plants to spread growth by settling in other parts of the lake also must be considered. Aquatic plant cutters also tend to entrain a large number of small fish, turtles, and other aquatic organisms which will be removed from the lake if not screened out by the operator. Because of these problems weed harvesting has become subject to regulation and permitting by the Indiana Department of Natural Resources. Harvesters are often the only effective option for controlling excessive growths of stout native plants that do not respond well to other control methods. They are also often employed in areas where regulatory permitting excludes the use of pesticides.

•Control of Eurasian watermilfoil and Curly-leaf Pondweed with Aquatic Contact Herbicides:
Several aquatic contact herbicides are available for use in Indiana lakes. Aquatic pesticide applications on Indiana public lakes are subject to review and permitting on a seasonal basis with the Indiana Department of natural Resources. In addition aquatic applicators for hire must be licensed through the office of the Indiana State Chemist. In aquatic herbicide applications chemical products are typically dispersed over target plants as liquid or granular formulations using specialized boat-mounted equipment. Most contact herbicides function by eroding the cell membranes of plant tissue disrupting

plant functioning. Control is usually achieved quickly with susceptible plant species often dropping out in less than one week. Aquatic herbicide choices are somewhat limited as EPA approved products must not cause damage to untargeted organisms, provide a hazard to lake users, or leave harmful residues in the environment. Because of these requirements most contact herbicides have a short half-life in an aquatic environment, being lost to soil adhesion, photodegradation, or bacterial decomposition shortly after application. By both accident and design, most aquatic contact herbicides are selectively effective against obnoxious exotic species with Eurasian milfoil, and Curly-leaf pondweed being especially susceptible. Stout native species such as some of the larger native pondweeds and most of the native milfoils largely remain unaffected by marginal applications on larger lakes. This provides the advantage of allowing selective control, dropping out invasive exotics and leaving the native plant community to recover and capitalize on available light. Selective susceptibility needs to be considered when making herbicide choices so that appropriate plant community effects occur. Contact herbicides tend to leave plant root structures intact so regrowth often begins shortly after treatment. Multiple treatments can be needed in some cases to maintain full-season control. Use of some herbicides requires that lake activities such as swimming or lawn irrigation be restricted near the treatment area during a post treatment waiting period. Water-use restrictions generally apply within 100 feet of the application area. Waiting periods for swimming and other water-uses vary between zero and 120 days depending on the product used.

•Aquatic Plant Control with 2-4-D Granular Translocated Aquatic Herbicide:
Granular formulations of 2-4-D herbicide have been used for many years to control Eurasian watermilfoil. In lawn, agricultural, and aquatic applications 2-4-D is used to selectively control plants which are biologically classified as “broadleaves”. Aquatic plants in this category include Eurasian and Native milfoils and Coontail *Ceratophyllum echinatum*. 2-4-D is a translocated or “systemic” aquatic herbicide. It is absorbed by target plants and transported through their vascular systems, affecting remote parts of the plant including the root structure. This offers the theoretical advantage of actually killing more plants and providing longer term control. Well-timed 2-4-D applications in some cases provide seasonal control of Eurasian watermilfoil with regrowth occurring the following season. Occasionally reapplication is needed within the same season. With milfoil infestations, 2-4-D offers the advantage of being highly selective for milfoil with the pondweeds, and most other native plants remaining completely unaffected. Granular 2-4-D use typically restricts swimming near the treatment area for one day, and requires a waiting period on the use of lake water for lawn irrigation, so ornamental and garden plants will not be damaged.

•Aquatic Plant Control with Trichlopyr Translocated Aquatic Herbicide:
Available in a liquid formulation or granular flake (OTF) as Renovate 3® aquatic herbicide, trichlopyr offers broadleaf specific systemic control of aquatic plants in a liquid herbicide. This offers the advantage of easier handling and application over 2-4-D. Results have been similar to the use of 2-4-D. Improved application techniques and the use of adjuvants show some promise of possible providing multi-seasonal control with the use of Trichlopyr. The current labels allows the restricted use of dosed lake water to be adjusted in accordance with lake-water assay results, greatly reducing the time of restriction in most cases.

•Aquatic Plant Control with Fluridone Translocated Aquatic Herbicide:
Two aquatic herbicide formulations containing fluridone are currently available under the trade names Avast!® and Sonar®. Fluridone is an extremely effective aquatic herbicide at very small concentrations in lakes and ponds, while it displays a relatively low toxicity to fish and mammals. Unlike most other aquatic herbicides it’s also environmentally persistent, often remaining in the dosed waterbody in minute, but measurable amounts over the course of several months. Fluridone is absorbed by plant shoots from water, and from hydrosoil by the roots of aquatic vascular plants. In susceptible plants, fluridone inhibits the formation of carotene. In the absence of carotene chlorophyll is rapidly

photodegraded causing plants to become chlorotic (whiteish) and eventually drop out. Like many other herbicides fluridone is capable of a high degree of selective control at proper dosages. Within the assemblage of plants in most Indiana lakes, Curly-leaf pondweed and Eurasian watermilfoil are most susceptible. For control of Eurasian milfoil fluridone is introduced into a lake at the calculated rate of six to twelve parts-per-billion. Assays are often performed within the first two weeks after initial dosing to assess a hit or miss on a target concentration. A second dosage is often used to maintain the target concentration for a period of 60 to 90 days as the product is allowed to work. At a 6 PPB dosage rate fluridone is highly selective for Eurasian watermilfoil and Curly-leaf pondweed. Control typically lasts the entire season with occasional carryover effects during the second season. At dosages of 10 to 12 PPB Eurasian watermilfoil control is typically complete by the end of the first season and often extends through the second season, but a variety of native plants may be impacted. One major advantage of Fluridone use is its persistence and slow activity. During the extended treatment period the product mixes throughout the upper strata of the entire lake basin, allowing it to reach all exotic target plants in contact with the water. This also means that consideration must be given to possible impacts downstream from the target lake. Because of its slow rate of activity fluridone also offers the advantage of providing for gradual breakdown of target plants, providing a more gradual release of nutrients than faster acting herbicides. This decreases the chances of developing oxygen deficits or excessive algal blooms in shallow lakes. Because of the high cost of fluridone herbicides, their use is often reserved for lakes with extensive littoral areas showing profound mat-forming infestations and severely impaired recreational use. The only water-use restriction associated with fluridone is a wait on the use of lake water for lawn and garden irrigation of 14 to 30 days depending on dose rate.

•Aquatic Plant Control with Triploid Grass Carp (White Amur):
The Asiatic Grass Carp *Ctenopharyngodon idella* have become popular as an introduced exotic biological control for rooted aquatic plants in ponds and southern U.S. lakes. Grass Carp are native to river systems of Russia and China. The species was first imported to the southern United States in 1963. Like most biological controls herbivorous grass carp have remained extremely popular despite some problems associated with their use. Stocking of grass carp was initially illegal in many states including Indiana. Because grass carp are a possibly detrimental exotic species, resource managers feared a destructive establishment of viable wild populations. This process had already occurred with the common carp which remains a destructive influence in our aquatic habitats. Proponents of the plant-eating fish argued that viable breeding habitat for the carp was not present in the United States. That argument was refuted when viable reproduction was noted in the 1980's in tributaries to the Mississippi. When a technique was developed for producing genetically altered triploid grass carp stock with greatly reduced fertility, laws in many states including Indiana were changed to allow stocking of the sterile fish in private waters. The possibility still exists for fish producers to bypass the necessary hatchery process and market fertile fish. Illegally stocked fertile grass carp have been found in some locations. Use of any grass carp remains illegal in twelve states including Michigan. Despite remaining controversy, some regulatory agencies encourage their use in ponds and lakes publishing stocking guidelines and even offering the fish for sale. Grass carp have been introduced into thousands of private ponds and many larger reservoirs in the southern United States with mixed results. Often stockings in large waterbodies bring either complete eliminations of vegetation or very little decline at all (Cassani 1995). Grass Carp are selective feeders and unfortunately tend to prefer most native plant species over Eurasian watermilfoil. Results of grass carp stocking vary with the plant species assemblage present in stocked waters and variations in Lake Morphometry. In general, stocking at low rates can be expected to produce a shift in plant biomass away from preferred species food plants, toward unpreferred. At high stocking rates the fish will consume all rooted aquatic vegetation in the system. This causes a shift in plant biomass toward planktonic and filamentous algae as fish waste and feeding activity boosts lake nutrient levels. At sustained high numbers, the fish will consume filamentous algae, emergent aquatic plants, and even terrestrial vegetation within their reach at the lake's edge. Shoreline erosion can become a problem when this occurs. At the end result of sustained

high stocking rates lake plant biomass will be maintained in planktonic algae, which the fish are unable to utilize as a food source. This can obviously lead to water clarity problems and unstable oxygen levels, especially in the temperate northern U.S. Successful use of grass carp on ponds and in large southern lakes often trades water clarity for alleviation of rooted plant problems. This technique can be effectively employed where water clarity and high oxygen levels are not a priority. In the case of most Indiana natural lakes where water quality and clarity is a high priority, use of herbivorous fish as a management technique would not be wise or legal.

•Benthic Barriers for Aquatic Plant Control

Sheets of plastic or rubber material have been used to exclude aquatic plant growth. Usually owners of small ponds or swimming areas will employ this technique by placing the liner on the bottom and depositing sand or pea gravel on the liner. One drawback with this technique is the tendency for gasses to build up beneath impermeable liner material pushing it up from the bottom. This occurs as decomposition in the lake sediments produces hydrogen sulfide and carbon dioxide gasses. Using mesh liners or permeated liners can alleviate this problem somewhat, but obviously will allow plants to grow through the liner. Bottom liners also effectively exclude areas of benthic habitat and are generally not permitted by IDNR in public lakes for this reason.

Option	Benefits	Drawbacks
No Control	No dollar cost, No water-use restrictions	Further loss of plant diversity, degraded fish & wildlife value, possible further Sportfish stunting, Impeded recreational use, aesthetic problems
Biocontrol Weevils	No swimming restrictions, No watering restrictions	Often ineffective, Cost prohibitive
Biocontrol Grass Carp	No water-use restrictions, possible multi-season control	Results not-predictable, illegal in Indiana public waters, may cause water clarity/quality problems, limited selectivity
Harvesting	No water-use restrictions, Removes some nutrients from lake	May hasten spread Eurasian milfoil through fragmentation and hydrosoil disturbance, Expensive, May result in regrowth within same season, Requires plant disposal site, Non-selective
Benthic liners	No water-use restrictions, possible multi-seasonal control	Impairs benthic habitat, Not generally permitted in Indiana Public Waters, Not feasible in deep water, Inherent maintenance problems
Aquatic Pesticides (2-4-D)	Highly selective control, Very effective	Intermediate expense, difficult application, Swimming and irrigation restrictions, Generally provides one season's control
Aquatic Pesticides(Renovate)	Highly selective control, Very effective	Expensive- materials expense, Swimming and irrigation restrictions, Generally provides one season's control,
Aquatic Pesticides (Sonar a.s.)	Highly selective control, Very effective, Multi-seasonal control	Expensive product, irrigation restriction, possible damage to non-target vegetation
Aquatic Pesticides (contact herbicides) (diquat dibromide or endothols)	Some selectivity, Very effective, fast acting, least expensive application	Generally provides on season's control, Possible regrowth in late season, Swimming, Irrigation, and possible fish consumption restrictions

Table 12 General Plant Management Alternatives, Drawbacks and Advantages

At Hamilton Lake the best management practices with regard to fostering and encouraging the growth of native aquatic plants will include any lake or watershed practices which help to improve water clarity. Sources of nutrients and sediments in developing and tilled areas should be addressed and efforts at wetland and stream bank restoration should be continued. Prior studies indicating a good potential for wetland creation/restoration should be reviewed for possible follow-up. Current efforts to address problems in the Black Creek watershed should be continued. Long term gradual systemic control of non-native invasive plants such as that provided by "whole lake" type treatments should be preferred whenever possible to mitigate nutrient releases from decomposing targeted plants. Treatments of native plants and algae should be limited to high use areas. Applying continuous selective pressure away from non-native invasive plants while working to improve water clarity and reduce nutrient levels will be the best long-term strategy for restoring and maintaining a diverse native aquatic plant community.

10.0 Public Involvement

Many parties have an interested in plant management at Hamilton Lake. Lake residents and non-resident lake users who launch watercraft at the public access (to boat, fish, and ski) are directly affected by plant management. Many area businesses are also affected. A marina, taverns and restaurants are located on the shore of Hamilton Lake and serve local residents, lake residents, boaters, and fisherman. Area business owners and employees as well as the town of Hamilton and its residents benefit from a healthy Hamilton Lake that supports local development, cottage rental, good property values, and attracts recreational users to the area. A public meeting for Hamilton Lake's plant management program was incorporated into the regular association meeting on June 23, 2007. Approximately 85 people were in attendance; most were lake resident property owners. The number of people present was typical of Hamilton Lake Association annual meetings. Information about plant management at the lake was presented by Aquatic Enhancement & Survey, Inc., and Weed Patrol, Inc. Samples of Curlyleaf pondweed and Eurasian watermilfoil were passed around the group to familiarize those in attendance with these invasive plants. A discussion was held about the status and goals of the Plant Management Plan and opportunity was provided for lake residents to ask questions and generate input regarding the lake's plant management and water-use restrictions involved. The Lake User Survey below was distributed to those present, filled out, and collected. Sixty three surveys were collected. Sixty respondents (98%) indicated that they were lake property owners; one (2%) indicated they were not. All were association members. When asked how long they had resided at the lake 26 respondents (43%) indicated they were 20+ year residents, 13 (21%) were 6-10 year residents and 13 (21%) were 11-20 year residents. Nine (15%) indicated 0-5 years of residency. All but two respondents 99%) indicated that the growth of aquatic plants had detracted from their enjoyment of the lake at some point. When asked whether Hamilton Lake contained aquatic plants in nuisance quantities at the current time (post Curlyleaf treatment) 32 respondents (53%) marked "no" 28 (47%) marked "yes". Fifty four (90%) respondents indicated that they own or occupy lakeshore property while one (2%) was a channel resident and five (8%) did not own property at the lake. When asked whether they felt that the level of aquatic vegetation at the lake affects their property value 60 (97%) indicated it did, while only two (3%) said it did not. One hundred percent of respondents (63) were in favor of continuing efforts to control vegetation at Hamilton Lake. Overall the meeting was very well attended and participants were unanimous in their interest in continuing efforts to manage exotic plants at the lake. Most indicated that they were pleased with plant management results thus far.

Lake User Survey Hamilton Lake 6/23/07

1. Are you a lake property owner? Yes________ No_________

2. Are you currently a member of your lake association? Yes ___ No___

3. How many years have you been at the lake? (circle one) 0-5 years
6-10 years
11-20 years
more than 20 years

4. Has the growth of aquatic plants on Hamilton Lake ever negatively affected your enjoyment of the lake? Yes_____ No_______

5. How do you use the lake? (mark all that apply)
___Swimming ___Irrigation (including lawn) ___Enjoy View and Atmosphere
___Boating ___Fishing _____View Wildlife ______Skiing/boarding/Tubing

Other ____

6. Do you feel that Hamilton Lake has Aquatic plants in nuisance quantities at this time(2007)? Yes ___ No ___

7. Do you own or occupy property on a _____channel ______Lakeshore______Neither

8. Do you feel the level of vegetation in the lake affects your property values? Yes ___ No ___

9. Are you in favor of continuing efforts to control vegetation on the lake? Yes ___ No ___

10. Mark any of these you think are problems on your lake:
___ Too much fishing
___ Canada Geese
___ Excessive boat traffic
___ Dredging needed
___ Too many aquatic plants
___ Not enough aquatic plants
___ Poor water clarity
___ Additional Speed enforcement needed

Other____

Please add any additional comments on the back:

☐ Check here if commenting on the back

11.0 Public Education

The Hamilton Lake Association should set reasonable goals for increasing awareness among lake users about lake health issues. The association newsletter, annual summer meeting, monthly board meetings, and website can serve as the primary vehicles for disseminating information. Hamilton lakes summer meeting saw a good attendance of approximately 85, but efforts could still be made to encourage more of Hamilton Lake's approximately 500 lakeside homeowner's to attend the annual summer meeting. Public education efforts should address the following areas:

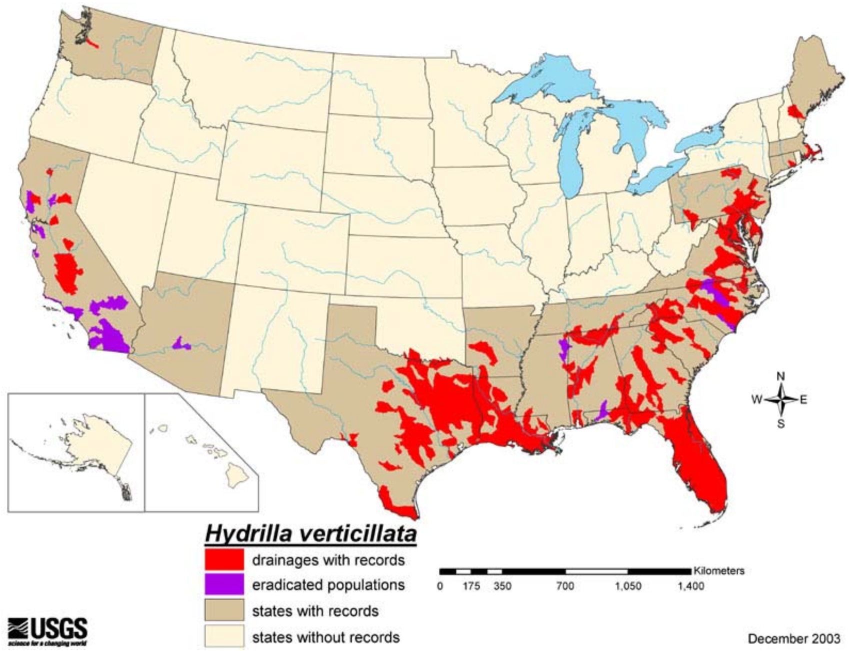
●Prevention of the spread of Exotic Invasive Aquatic and Wetland Species.
An effort should be made to make lake users aware that their own boat trailers could have introduced Curlyleaf pondweed or Eurasian watermilfoil to Hamilton Lake or could spread these plants to other lakes if care is not taken to remove vegetative debris. Now that Hydrilla *Hydrilla verticillata* an invasive plant new to Indiana has been discovered in Lake Manitou prevention of the vegetative spread of aquatic plants will be especially important. Basic plant identification should be addressed so new invasive species appearing can be spotted early on by the lake users. Information on Hydrilla is presented in the next section.

●Prevention of lake nutrient enrichment.
An effort should be made to encourage all lake residents to switch to no-phosphorus lawn fertilizers. Residents should also be made aware that soils lost through erosion in the watershed carry nutrients into the lake's waters as do sediments mobilized from the lake's bottom and shoreline by watercraft. Area residents should be aware of proper erosion control techniques at construction sites within the watershed and be aware that the Hamilton Lake Association is working toward addressing nutrient and sediment sources in the Black Creek watershed and needs their support.

●Expectations and water use restrictions associated with Plant Management.
Residents should be made aware that LARE funds are intended to address only Exotic species of aquatic plants and control of plants will not occur throughout the whole lake. It is also important that residents understand and obey the posted water use restrictions associated with any chemical treatments performed. Because Hamilton Lake is very nutrient-rich it supports high numbers of fish or a relatively high fish "biomass". Similarly it can be expected to maintain a high plant biomass. Residents need to remain aware that plant management cannot eliminate plant biomass from the lake, but only pushes that biomass toward more desirable and ecologically sound species. Residents should be made aware that native plant treatments should be moderated with this in mind. Excessive elimination of native plants may cause plant biomass to shift to blue-green or filamentous algae which could be problematic.

11.1 Hydrilla and it's implications for Hamilton Lake

Keeping lake residents and users aware of the possibility of bringing in new invasive species on watercraft trailers will be especially important now that Hydrilla has been found in Indiana. Hydrilla *Hydrilla verticillata* is an invasive submersed aquatic plant thought to be native to Africa, Australia, and parts of Asia. As a hearty growing plant Hydrilla was used in aquariums and this led to its introduction into Florida waters in 1960. Since then Hydrilla has spread to become the single most problematic plant in the United States. (See USGS map below) In Florida alone millions are spent in controlling the growth of Hydrilla each year. The potential exists for the same type of damage on Indiana waterways if Hydrilla is allowed to spread. Like many invasive aquatic plants Hydrilla can form dense surface mats depriving native plant communities of light, decreasing plant community diversity, and causing serious impairment of recreational activities including fishing, swimming, and boating.



Known occurrences of Hydrilla in the U.S. in 2003. From the USGS website, http://nas.er.usgs.gov/taxgroup/plants/docs/hy_verti.html

Hydrilla mats clog the surface of Lake Conroe Texas. Photo courtesy of Earl Chilton, Texas Parks and Wildlife Department

Hydrilla can spread by fragmentation or the production of seeds, tubers (root structures), or turions (seed-like plant buds). Because of the potential for spread through fragmentation, plant material hitching a ride on watercraft trailers is probably a major mechanism of introduction. Tubers and turions can be very hearty, surviving dry periods or herbicide treatments and remaining hidden in the lake bottom for extended periods of time. Because of these characteristics great ecological damage and recreational impairment can occur in watersheds colonized by Hydrilla. In 2006 Hydrilla was discovered in Lake Manitou and its outlet stream in Rochester Indiana (Fulton County). This is the first known occurrence of this plant in the Midwest. The Indiana Department of Natural Resources has devised a plan for eradicating and controlling the Hydrilla to prevent spread to other water bodies. Checks of other lakes in close proximity to Lake Manitou have not located any Hydrilla, so it is possible that the plant is only in and immediately downstream of Lake Manitou at this time. However, it's also possible that other lakes contain young Hydrilla infestations that have yet to be recognized so it's important that associations and lake residents learn to identify this plant. Acting early in spotting Hydrilla can help prevent spread and ultimately save a huge cost to the ecology and recreational value of Indiana lakes. At some point other infestations may occur as a result of plants being transported to Indiana from out-of-state. Whereas Hamilton Lake is a popular boating and sportfishing destination, there is a definite possibility that this plant could appear in the Lake in the future. Information on Hydrilla identification should be presented to the Lake users at meetings as a regular part of the lake resident educational program.

Hydrilla is similar in appearance to the native plant Elodea and also Brazilian elodea, an exotic (also recently found in Indiana). It forms long stems containing many whorls of short leaves. Photo Courtesy of Dr. John H. Rodgers, Jr.

11.1.1 Hydrilla Identification

Hydrilla strongly resembles the native aquatic plant Elodea *Elodea canadensis* and the introduced species Brazilian elodea *Egeria Densa.* Both these species can be found in Indiana although the occurrence of Brazilian elodea has been very limited thus far. Hydrilla is a long slender plant that sometimes branches and has short leaves arranged around the stem in a star-like (whorled) pattern. Characteristics which differentiate Hydrilla from Elodea and Brazilian Elodea include a typical leaf count of five in the whorl. Brazillian elodea typically has four to six leaves but never three, and native Elodea usually has three. (fig 31) Small teeth are also present on the midrib of Hydrilla leaves and may give the plant a "rough" feel. Hydrilla also has small serrations along the leaf edges (fig 32). Another distinguishing characteristic of Hydrilla is the presence of tubers (.2 to .4 inch long off-white structures attached to the root) (fig 33).

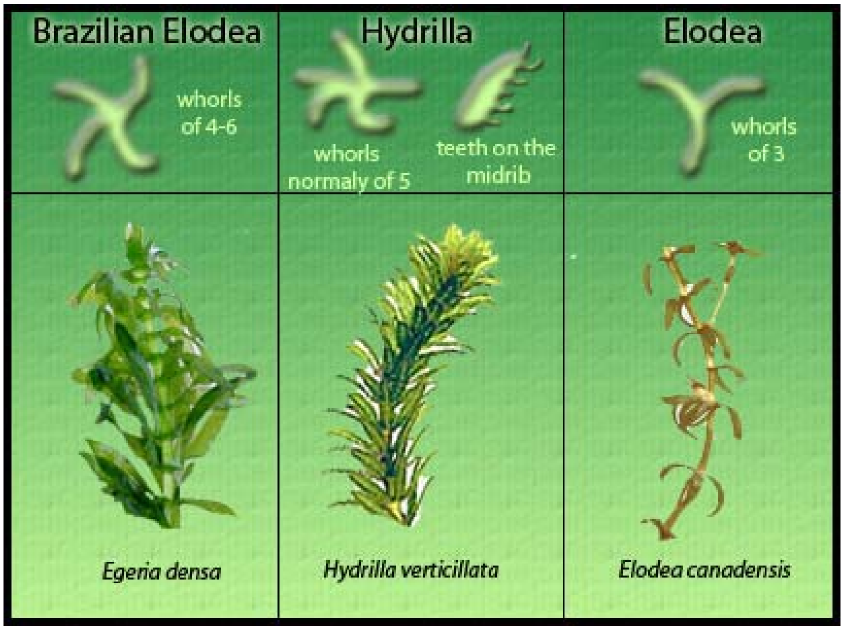


Fig. 1 Brazilian elodea has a typical leaf count of 4-6, while Hydrilla's is usually 5, and Elodea's 3. Drawing courtesy of Rob Nelson at ExploreBiodiversity.com

Fig. 2 Edges of Hydrilla leaves have fine serrations visible upon close examination. Photo Courtesy of Dr. John H. Rodgers, Jr.

Fig. 3 Hydrilla plants with tubers attached. Photo courtesy of King County Natural Resources and Parks, Water and Land Resources Division.

Anyone noting the presence of Hydrilla or Brazilian elodea is asked to immediately contact Doug Keller, Invasive species coordinator for the Indiana Department of Natural Resources at 317-234-3883, email: **dkeller@dnr.in.gov**. If you have questions about the identity of aquatic plants found, photos of the plants can be e-mailed to Doug for basic identification to determine if further action is required. More information on stopping the spread of invasive aquatic species is available online at **http://www.protectyourwaters.net/**

12.0 Integrated Management Action Strategy

Exotic plant management at Hamilton Lake should take an approach consisting of three tiers of action working toward this plan's primary goals:

Tier 1. **Nutrient and Sediment control.**
The Hamilton Lake Association should continue to be vigilant in spotting and addressing nutrient and sediment sources in the watershed, stopping pollutants at their source before water quality can be impacted. Progress made so far in addressing the Black Creek drainage should be continued.

Tier 2. **Public Education.**
The above educational points can potentially prevent a very costly infestation of new exotic plants and animals at the lakes, saving resources that can be utilized to address current problems.

Tier 3. **Non-native Plant Control.**
Addressing the submersed aquatic non-native plants present at Hamilton Lake on a lakewide basis with professional applications of EPA approved aquatic pesticides and monitoring results closely can potentially limit their spread while providing relief to lake users. Treatment regime detail is provided in the budget and timeline information in the next section. Reasonable success benchmarks for the 2008 applications will be to maintain a 10 percent or less occurrence of dense Curlyleaf pondweed and Eurasian watermilfoil growth in Hamilton's littoral area and 5% or less occurrence of Eurasian milfoil and Curlyleaf pondweed in the July Tier II Survey. The management regimes detailed below are based on a worst case scenario and long-term best management practices. The cost estimates assume that Curlyleaf pondweed will continue to occur at the 2007 season level. Because IDNR may opt not to fully fund a 90 percent cost share portion of exotic plant control in any given season, the Hamilton Lake Association should prepare to bear a significant portion of the exotic plant control costs. If available funding should not be sufficient to sustain the needed exotic plant control in a given season Eurasian watermilfoil control should be a priority. Curlyleaf pondweed treatments could be limited to priority "high use" areas at the direction of the Lake Association. Because untreated Curlyleaf pondweed typically drops early in the season, untreated Curlyleaf plants will have less impact than untreated Eurasian watermilfoil.

13.0 Project Budget & Timeline

2008 Season ●**Success Benchmarks:** 5% or less occurrence of Curlyleaf and 5% or less occurrence of Eurasian milfoil in July Tier II Survey			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
April/May (soon after emergence)	Treat Curlyleaf pondweed as needed (.5-1ppm Aquathol K)	170	51,000.00
May	Begin Eurasian treatments on main lake as needed (granular 2,4-D)	50	20,000.00
May	6 ppb fluridone application for Eurasian m. (Crystal Bay and Cove) Initial dose, bumps, and assays	40.1	9800.00
June	Algae/native plant treatment as needed/permitted		(1200.00 HLA costs)
July	Tier II Survey		1800.00
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		1900.00
	Total Exotics Cost, Pesticide Applications		**$80,800.00**
	Total Exotics Cost, Consultant		**$5650.00**
	Exotics Total		**$86450.00**
	Misc. Algae & Native Treatments		**$1200.00**
	Total		**$87,650.00**

2009 Season			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
April/May (soon after emergence)	Treat Curlyleaf pondweed as needed (.5-1ppm Aquathol K)	170	51,000.00
May	Begin Eurasian treatments on main lake as needed (granular 2,4-D)	100	40,000.00
June	Algae/native plant treatment as needed/permitted		(1200.00 HLA costs)
July	Tier II Survey		1800.00
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		1900.00
	Total Exotics Cost, Pesticide Applications		**$91,000.00**
	Total Exotics Cost, Consultant		**$5650.00**
	Exotics Total		**$96650.00**
	Misc. Algae & Native Treatments		**$1200.00**
	Total		**$97850.00**

2010 Season			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
April/May (soon after emergence)	Treat Curlyleaf pondweed as needed (.5-1ppm Aquathol K)	170	51,000.00
May	6ppb bump 6 whole lake sonar treatment	843	91,600.00
June	Algae/native plant treatment as needed/permitted		(1200.00 HLA costs)
July	Tier II Survey		1800.00
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		1900.00
	Total Exotics Cost, Pesticide Applications		**$142,600.00**
	Total Exotics Cost, Consultant		**$5650.00**
	Total Exotics		**$148,250.00**
	Misc. Algae & Native Treatments		**$1200.00**
	Total		**$149,450.00**

2011 Season			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
April/May (soon after emergence)	Treat Curlyleaf pondweed as needed (.5-1ppm Aquathol K)	170	51,000.00
May	Begin Eurasian treatments on main lake as needed (granular 2,4-D)	20	8000.00
June	Algae/native plant treatment as needed/permitted		(1200.00 HLA costs)
July	Tier II Survey		1800.00
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		1900.00
	Total Exotics Cost, Pesticide Applications		**$59,000.00**
	Total Exotics Cost, Consultant		**$5650.00**
	Total Exotics		**$64650.00**
	Misc. Algae & Native Treatments		**$1200.00**
	Total		**$65850.00**

14.0 Monitoring and Plan Update Procedures

The Hamilton Lake Aquatic Plant Management Program should be monitored and updated on an annual basis. Monitoring will consist of monitoring not only the lake's plant community, but the thoughts and opinions of the lake's users. To monitor the lake's plants, exotic growth will be remapped each spring and compared with the previous season's growth pattern. A tier II survey in the late season after treatment has been initiated will serve to characterize the lake's overall plant community statistically and also gage if treatment bench marks have been attained. If treatment response bench marks are not attained changes in the treatment timing, chemical used, or integrated approach will all be options for setting a new course toward success. To monitor the thoughts and opinions of lake users at least one public meeting should be held annually and a survey distributed. An open forum at the meeting should exist to allow for discussion of water-use restrictions associated with treatments, new problems arising at the lake, or treatment effectiveness. Updates on program progress and developments should be issued in the Hamilton Lake Association Newsletter and on the Hamilton Lake Website.

15.0 Literature Cited

Weed Patrol, Inc. 2005, Hamilton Lake Integrated Aquatic Plant Management Plant Management Plan 2005-2009, Tony Cunningham, Weed Patrol, Inc 1922 Fieldhouse Ave., Elkart, IN 46517

IDNR 2007, Tier II Aquatic Vegetation Survey Protocol, May 2007, Indiana Department of Natural Resources, Division of Fish and Wildlife, 402 W. Washington St. Rm W-273, Indianapolis, IN 46204

Pearson, J. 2004, A sampling method to assess occurrence, abundance and distribution of submersed aquatic plants in Indiana lakes, Indiana Department of Natural Resources, Division of Fish and Wildlife, Tri-Lakes Fisheries Station, 5570 North Hatchery Road Columbia City, Indiana 46725

IDNR 2004 Survey of Hamilton Lake Fish Population and Fish Harvest, Steuben County, Larry A. Koza, Fisheries Biologist, Fawn River State Fish Hatchery, 6889 North State Road 327, Orland IN, 46776. 260-829-6241

IDNR 1997 Indiana Department of Natural Resources.. Exotic Plant Species In Indiana Lakes. Lake and River Enhancement Program, Division of Soil Conservation, Indiana Department of Natural Resources, Indianapolis, IN.

Aiken, S.G., P.R. Newroth and I. Wile. 1979. The biology of Canadian weeds. 34. *Myriophyllum spicatum* L. Canadian Journal of Plant Science 59:201-215.

Couch, R., and E. Nelson. 1985. *Myriophyllum spicatum* in North America. Pp. 8-18 in L.W.J. Anderson (ed.). First International Symposium Watermilfoil and Related Haloragaceae Species. 23-24 July 1985, Vancouver, B.C. Aquatic Plant Management Society, Vicksburg, MS.

Madsen, J.D., L.W. Eichler, and C.W. Boylen. 1988. Vegetative spread of Eurasian watermilfoil in Lake George, New York. Journal of Aquatic Plant Management 26:47-50.

Sheldon, S.P. 1994. Invasions and declines of submersed macrophytes in New England, with particular reference to Vermont Lakes and herbivorous invertebrates in New England. Lake and Reservoir Management 10(1):13-17.

Harza 1990. Feasibility Study Lake Enhancement Hamilton Lake Indiana, Harza Engineering Company, Chicago, IL

Harza Review 1991, Report for Environmental Review of Artificial Wetlands Designed to Enhance Water Quality of Hamilton Lake, Indiana, Harza Engineering Company, Chicago, IL

Harza Exploration 1991, Report of Subsurface Exploration and Laboratory Testing. Hamilton Lake Enhancement Project, Wetland Design Sites. Harza Engineering Company, Chicago, IL

Harza 1999, Supporting Design Report for Wetland Development to Improve the Water Quality of Hamilton Lake. Harza Engineering Company, Chicago, IL

16.0 Appendices

Appendix 16.1
Plant Survey Data Sheets

Appendix 16.2
Treatment Calculation Data and Maps


41 ac.
Fluridone Treatment for Eurasian watermilfoil
Crystal Cove
Crystal Bay & Crystal Cove
41 Surface Acres
5.5 foot mean depth
225.5 ac-ft
Approx. $1500.00 Material Cost Per 6ppb Dose
(3.65 Qts Sonar at Gallon Retail Prc)
Assuming at least 28 day Residence Time
2 Fastests day 7
3 ppb bump day 14
2 Fastests day 21
3 ppb bump day 28
2 Fastests day 35
3 ppb bump day 42
2 Fastests day 49
3 ppb bump day 56
Crystal Bay
Total Materials $4500.00
$800.00 assays
$4500.00 application costs
Total Fluridone Costs $9800.00
Treat 41 acres with 2,4-D @ $400.00 per $16400.00

Hamilton Lake Fluridone Dosage Worksheet

Lake Initial dose 15 ft strata	6 bump 6		inside	
input in outlined cells	0 contour	5 contour	15 contour	ppm target
Surface area	843.00	591.00	326.00	0.006

volume of water to 5' contour (ac-ft)	3566.40
area of 5 foot contour * five feet (ac-ft)	2955.00
volume of water in zero to 5' donut (ac-ft)	611.40
quarts to apply to zero to 5' donut	**9.98**
volume of water 5' to 15' contour (ac-ft)	4519.79
Volume of donut hole area below 5ft to 15'	7474.79
quarts to apply to donut hole 5'-15'	**121.99**
total quarts	**131.97**
total gallons	**32.99**

Lake bump dose, 15 ft strata	6 bump 6			
input in outlined cells	0 contour	5 contour	15 contour	ppm target
Surface area	843.00	591.00	326.00	0.003

volume of water to 5' contour (ac-ft)	3566.40
area of 5 foot contour * five feet (ac-ft)	2955.00
volume of water in zero to 5' donut (ac-ft)	611.40
quarts to apply to zero to 5' donut	**4.99**
volume of water 5' to 15' contour (ac-ft)	4519.79
Volume of donut hole area below 5ft to 15'	7474.79
quarts to apply to donut hole 5'-15'	**60.99**
total quarts	**65.98**
total gallons	**16.50**

TOTAL MAX PRODUCT FOR PROJECT(GAL) **49.49**

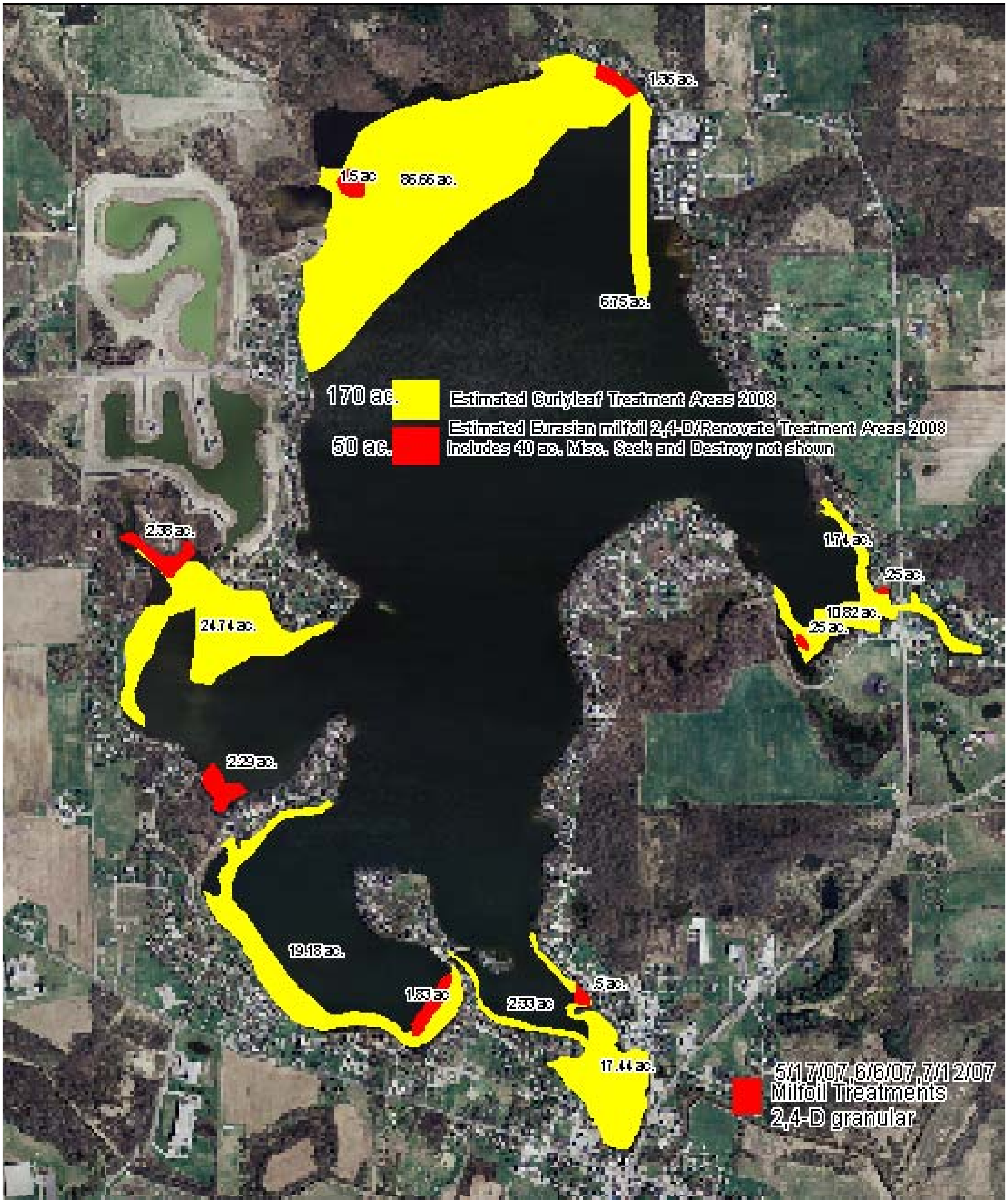
Hamilton Lake Hydraulic Residence Time Calculation

Because there is no U.S. Geological Survey operated a stream-flow gauging station on the Hamilton Lake outlet to tell us how much water flows through the lake in response to precipitation, outlet outflow data from another nearby watershed of similar soil types and precipitation was used. This figure will be used to calculate contributions to the lake's water from surface rain and snow melt runoff. The U.S.G.S. operated a stream-flow gauging station on the outlet from Lime Lake and Lake Gage in Steuben County between 1969 and 1986. This provided outflow data specific to the same county and sharing many of the same soil types as the Hamilton Lake watershed. A mean annual outflow figure for the period of record provided a starting point for runoff calculations. Runoff for the entire 17.5 square mile watershed was recorded at 6.25 inches annually. Dividing the runoff figure by mean annual precipitation (38.89 inches) for the same period of record produced a runoff coefficient of .16. This coefficient was then utilized in providing a rough estimate of the drainage from the 10873 acres of land in Hamilton Lake's watershed at 5653 acre feet of water.

Annual Watershed Rain and Snow Contributions to Hamilton Lake

Watershed	Watershed Acreage
Watershed Acres	10873
Est. Runoff Coefficient	0.16
Annual Precip. (in)	38.89
Annual Precip. (ft)	3.24
Annual Runoff (ft) (Ann. Precip.)*(runoff coeff)	.52
Ann. Runoff Vol. (ac-ft) (Ft. runoff)*(ac. watershed)	5653
Lake Volume (802 ac @ 21 foot avg. depth)	16842
Residence time (yrs) (Lk vol/ann. Runoff)	3
Upper 10 ft Lake Volume (802 ac @ 10 foot depth)	8020
Residence time of upper ten feet (yrs) assuming no mixing of rainfall/runoff below 10 feet	1.41

Appendix 16.3
IDNR Vegetation Permit


1.36 ac.
1.5 ac
86.66 ac.
6.75 ac.
170 ac.
Estimated Curlyleaf Treatment Areas 2008
50 ac.
Estimated Eurasian milfoil 2,4-D/Renovate Treatment Areas 2008
Includes 40 ac. Misc. Seek and Destroy not shown
2.38 ac.
1.74 ac.
.25 ac.
10.82 ac.
.25 ac.
24.74 ac.
2.29 ac.
19.18 ac.
1.83 ac
2.33 ac
.5 ac.
17.44 ac.
5/17/07,6/6/07,7/12/07
Milfoil Treatments
2,4-D granular

Appendix 16.4
Pesticide Use Restrictions / Pesticide Labels

Appendix 16.5
Resources For Aquatic Vegetation Management
(funding and technical assistance)

Appendix 16.6
State Regulations Relevant to Aquatic Plant Management